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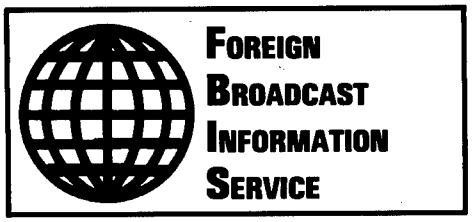

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ADVANCED MATERIALS

Growing Use of Composite Materials in International Aeronautics Industry Discussed

92WS0727A Duesseldorf VDI NACHRICHTEN in German, 26 Jun 92 p 26

[Article by Burkhard Boendel]

[Text] In aeronautics and space travel the changeover from metal to fiber composite materials is imminent. For if production and repair work can be simplified and production costs lowered by new composite processes, modern composites will begin to dominate the use of materials in aeronautics. And because of the ever-growing demand for transportation and rising fuel costs, weight saving is more important and more worthwhile than ever.

Fiber composite materials are going through "a precipitous upswing," in the opinion of Diploma-Engineer Stefan Kupczyk, as he discusses the current trend. According to the fiber experts at Dornier, Ludwigshafen, this applies to the number and extent of the fields of application as well as to the technical advances of fiber composites themselves.

The rosy future prospects of fiber composites are not surprising, for aeronautics and space travel are growing at the present time at a phenomenal rate. In a recently published market study Deutsche Airbus, Hamburg, for example, expects the demand for commercial aircraft between the years 1989 and 2008 to be at 12,200 units, with a total value of $700 million. Of these, 5,500 aircraft will replace older jets, while the greater part will cover the growing demand for transportation at a yearly level of 5.5 percent.

At the same time in the longer routes more passengers and freight must be carried over the airways in the face of increasingly expensive transportation costs, caused primarily by rising fuel prices. For the construction materials used in aircraft this means one thing above all: weight saving. Thus the replacement of previously used metals such as aluminium or titanium by composite materials made from fiber-reinforced plastics is moving ahead with great strides, since through their use a 30 percent reduction of an aircraft's unladen weight is made possible.

Actually in the opinion of Diploma-Engineer Karlheinz Hillermeier of the fiber manufacturer Akzo in Wuppertal: "The euphoria about the new materials, which was widespread during the eighties, is a thing of the past." But he hasn't thrown in the towel yet. "The realistic possibilities are now gradually being sounded out from economic and technical points of view," the fiber specialist reports.

How far this has progressed is shown by the fact that, according to Hillermeier, it is only a question of time when the first mass-produced aircraft will be manufactured with wings made completely of compostite materials. This should definitely happen within this decade. And in the next decade the entire airframe will be ready for composite materials. By the year 2000 the production capacity for carbon-fiber-reinforced plastics on a worldwide scale will accordingly almost triple to 14,000 tons, according to Akzo. And this is a conservative estimate.

There are three reasons for the dynamic growth of composite materials, whose share in the construction of an aircraft is predicted at 65 percent by the next millenium. In the first place the materials have become considerably cheaper; Hillermeier anticipates prices of DM100/kg to DM200/kg. "In this way we are gradually entering the region of competitive materials." In the second place processing and testing methods will be continuously further developed, so that dealing with the materials will become safer. Finally manufacturers have been encouraged by their experiences with the composite parts which they have used so far.

In this regard the new Airbus 340 has set new standards. Altogether the A340 includes about 4 tons of carbon-fiber-reinforced plastics, mainly for the tail assemblies, which are constructed completely from fiber-reinforced plastic. Already with the A320 the designers had used more than 15 percent fiber composite materials in the construction.

In particular two newly developed composite materials, which will be sold by Akzo, will be of the greatest interest for aeronautics in the near future—"Arall" (aramide-reinforced aluminium laminate) and "Glare" (glass-fiber-reinforced aluminium laminate). The materials can be used in primary areas of construction and cut down on weight by 30 percent to 40 percent.

These two composite materials have a similiar construction. Layers of aluminium sheeting with a thickness of up to 0.4 mm are pressed together with 0.2 mm-thick layers of a resin bonding agent with fibers aligned on one side, to form a laminate. The number of layers is decided by the request in each case. First and foremost, as compared to conventional aluminium alloys, fatigue symptoms are substantially improved. While 1.8-mm-thick aluminium material showed the unwelcome syumptoms after 150,000 flight cycles, no fatigue whatsoever could be detected in the Arall (1.3 mm thick) even after 1.5 million cycles. The laminate even stops propagated cracks after only 2 to 3 mm under simulated conditions of high flight stress.

Airbus Industrie, however, will evidently be betting more on glass fiber types in the future. Test results have shown that Glare on the whole demonstrates better qualities than Arall. The University of Delft, which has developed Arall materials which have already been used in space travel, has now received a contract from Airbus Industrie to carry out a design study for an A320 Glare

fuselage. By and large Airbus is assuming that weight reductions of 20 percent to 25 percent can thereby be achieved.

The use of Glare will, however, be limited for the time being by the fact that its price is 10 times greater than that of aluminium alloys. The installation of Glare is thus only worthwhile where the composite material can be used in place of titanium alloys—for example at the intersection of a longitudinal rivet seam and the frames, where previously sheets of titanium have been used to stop cracks. Through the replacement of titanium with Glare not only will about 100 kg be saved, but production will be considerably simplified, since the drill holes are easier to make.

Similar advantages are also offered by other structural components made of fiber composites, such as the rudder assemblies of the Airbus large capacity aircraft. Here, where previously more than 2,000 separate parts made of aluminium alloys had to be fitted together, the 20 percent lighter structural component made from carbon-fiber-reinforced plastic is assembled from less than 100 separate parts. As a result of this the number of joining elements has shrunk from over 60,000 to 5,800. It is no wonder that other producers, like Boeing, are also striving for this type of rudder construction. In the Boeing 777, which is scheduled to make its first flight in 1994, horizontal tail units and rudder units will also be made from carbon-fiber-reinforced plastics.

At the same time fiber composites are not the private domain of the large-capacity jets. The Do 328, a regional commercial aircraft with 33 seats which was recently put on the market by Dornier, also offers wide use of fiber composites, with duromer as well as thermoplastic matrix systems. In the ribs for the landing flaps, for instance, polytherimide (PEI) with reinforced carbon fibers is used. There are two particularly new structural components in this aircraft which are made of fiber composites. The entire tail section including the fuselage shells and planking of the tail assemblies is constructed of long-fiber-reinforced carbon-fiber-reinforced plastic, and the pressure frame, which separates the passenger cabin from the non-pressurized rear fuselage of the aircraft, for the first time in a commercial aircraft is made of aramide fiber-reinforced plastic.

Fiber composites are increasingly used also for less conspicuous and smaller structural components. Examples of this are the fresh water and sewage tank, which AEG Isolier- und Kunststoff in Frankfurt is providing for the A320, or fan blades for new engines, which are made at MTU in Friedrichshafen in the form of a carbon-reinforced plastic blade with a metallic foot.

Caption to Figure [Not Reproduced]

Fiber composite materials are not the domain of large-capacity jets alone. As this rear fuselage of the new Do 328, made from carbon-fiber-reinforced plastic, attests, regional commercial aircraft also offer wide utilization of composites.

German Company Develops Electrically Conductive Plastics

92WS0774A Stuttgart BILD DER WISSENSCHAFT in German Aug 92 pp 90-93

[Article by Wolfgang Hess, Klaus Jopp, Barbara Wantzen: "The Tension Grows"; first paragraph is BILD DER WISSENSCHAFT introduction]

[Text] Conductive plastics: A chemist challenges science. The developer of electrically conductive polymers is putting together a new theory which could drastically alter our understanding of polymer mixtures.

For a medium-sized company, Zipperling Kessler & Co. in Ahrensburg northeast of Hamburg is taking an unusual course. Because its managing partner Dr. Bernhard Wessling has mandated that the company perform its own basic research, i.e., an area of activity which only large groups otherwise perform.

Success affirms Wessling's decision. Because his company has developed the first intrinsically conductive plastic which retains this amazing property even after a relatively long period of time. (Intrinsic means: Conductive because of its chemical structure and not just as a result of adding soot to the mixture.) And what is the special contribution of Ahrensburg? For the first time the dispersible polyaniline developed there and a new dispersion process have tamed the quite unmanageable polymer conductor made of polyaniline—it is insoluble and will not melt—for use in innovative materials.

Some explanations: Dispersions are mixtures of two different materials. Some examples are milk, cocoa drinks, or shampoos. Materials can even be incorporated—i.e., dispersed—in polymeric plastics. Examples of this are colored pigments, fire retardants, or electrically conductive additives. Thus mixed with thermoplastic bulk plastics such as with PVC the polyaniline particles allow polymer alloys (chemists call them "blends") to transmit electrical current.

The raw polyaniline powder is not produced in northern Germany but overseas in a pilot system at Zipperling's licensee Allied Signal in Buffalo, New York. The conductivity of polyaniline can also be transferred to blends and calibrated over a range from 10^{-8} to 30 siemens per centimeter. Siemens per centimeter, abbreviated S/cm, is the commonly used unit of measure for electrical conductivity. By way of illustration: The semiconducting metal germanium has a conductivity of 10^{-2} siemens per centimeter, whereas with silver it rises to 67,000 S/cm.

Conductive polyaniline also withstands a significant amount of heat before it loses its characteristic material properties. A temperature of 100°C over the long term does not affect it. And even 240° are no threat to polyaniline as long as it does not have to endure this heat for more than a few minutes.

The first applications of the conductive plastic are shielding devices for electromagnetic radiation and

extremely thin transparent coatings. Wessling considers the fact that there are already firm customers for these products as proof that he is on the right track.

When he started out a good 10 years ago at Zipperling as research manager and began to work with intrinsically conductive polymers, that was nothing spectacular. Because at that time researchers in many chemistry labs were working with these materials. However, the initial euphoria about their discoveries was followed by more sobering considerations: Because they were all difficult to process. Most researchers attempted to chemically alter the nonmeltable and insoluble materials—not so Bernhard Wessling.

He accepted the properties of the polyaniline and produced powder from it which he stirred into other plastics. Chemists call such mixtures compounds. Admittedly, even today research has not adequately determined how the reaction mechanism is altered by this.

"All polymer processing was and continues to be primarily empirical; compounding is a black art," Wessling feels. But he does not mince his criticism: "Many companies and institutes are investigating polymer mixtures in the test tube where the extreme processing conditions which prevail in machines for plastic production are completely ignored."

At first, Wessling went out on a limb with the idea of making conductive plastics useable for industrial production by dispersion. Even his current comrade-in-arms Ron Elsenbaumer, former research manager at Allied Signal and currently a professor in the chemistry department of the University of Texas, concentrated completely on improving solubility.

Now Elsenbaumer thinks differently: "Wessling is unquestionably a pioneer in the area of conductive plastics. The fact that his ideas have helped him develop commercial materials speaks for itself."

Anyone who thinks that Bernhard Wessling is satisfied with this success is grossly mistaken. Wessling's ambition has more to do with theory than technology: He is firmly convinced that he has discovered a new theoretical principle which explains a great deal more than why many plastics are conductive. With his dispersion theory Wessling is currently managing to describe many astonishing practical results from the laboratory and production. The theoretician continues to make practical use of them: As a result of his data, his company often needs only about one-hundredth of the tests required to produce innovative compounds or blends. In addition to electrical conductivity, properties such as the impact strength and the flow behavior of plastics can now be more accurately predicted.

The godfather of Wessling's theory is the Russian-born Belgian Ilya Prigogine, who was awarded the Nobel Prize for Chemistry in 1977. Prigogine was recognized for his nonequilibrium thermodynamics in chemical reactions. Although it is still hardly included in chemistry textbooks, Wessling has occupied himself extensively with it.

A fundamental principle with Prigogine is the spontaneous formation of structures. This meaningless expression represents a very weighty discovery: Usually, in dispersions a uniform statistical distribution of the individual components is assumed. This is not the case in systems which are characterized by nonequilibrium thermodynamics. At any rate, that is what Wessling argues. Such systems react to the continuous addition of energy or matter with a characteristic change in the distribution of their material. Even the particle distribution of a dispersion is altered.

According to Wessling, the following occurs: If, for example, electrically conductive polyaniline powder is mixed into another polymer, the powder is first distributed extensively. Each individual particle is covered by a molecular polymer layer, a process which consumes a great deal of energy, during which the gas and moisture coating originally present on the particles is removed. Then, the powdered particles move close together and form small seams, which can be approximately 0.1 millimeter long but only 0.1 micrometer thick. If the dispersed powder exceeds a thermodynamically characteristic concentration, the seams band together into three-dimensionally linked chains. These chains pervade the polymer system and thus assure that current can flow through the entire polymer.

The production of the dispersion and its subsequent self-organization can be explained—according to Wessling—by Prigogine's nonequilibrium thermodynamics. The chemist calls the structures found "dissipative."

The medium-sized company in Ahrensburg has clearly profited from the basic research. Within seven years, total production was increased from 10,000 to 20,000 metric tons—and the number of employees went from 70 to 200.

Meanwhile, at Zipperling additional thermoplastic blends are being developed, which in addition to electromagnetic shielding also can be used as antistatic coatings or sensors.

The path to economic success seems to be wide open: Most large companies have completely or largely pulled out of the development of conductive polymers. These even include BASF. The word from Ludwigshafen is in fact that research is continuing. However, it also heard that the activities have been cut back. No solid information is provided about the thrust there. Also, no one is willing to comment on the developments at Zipperling Kessler & Co. Less reserved is Dr. Volker Enkelmann of the Max Planck Institute for Polymer Research in Mainz, who speaks with respect about the high standards of compounding at Zipperling, but is restrained with regard to Wessling's theory: "I myself am skeptical about it. If he succeeds in controlling conductivities reliably over the long term, this is a great technical advance.

However, an empirical description of the properties of the material seems more appropriate to the complex multicomponent systems than a detailed theory. Because this carries the risk that data acquired experimentally might be interpreted more favorably than is merited."

In contrast, Werner Ebeling, professor of theoretical physics at Berlin's Humboldt University, assesses Wessling's theory positively. "The systems investigated are extraordinarily complex. However, the theory seems capable of describing most of the phenomena." Ebeling's arguments carry weight since as a scientist he has worked all his life with the emergence of natural structures.

The scientific conflict has thus been programmed and the tension is increasing: It remains to be seen whether Wessling the outsider will manage to change the doctrine.

AEROSPACE

French Research Projects Aboard Mir Described

92BR0663 Paris SCIENCES ET AVENIR in French Aug 92 pp 18-23

[Article by A. Ducrocq: "A Frenchman in Russian Orbit"]

[Text] Michel Tognini, the "stand-in" for French astronaut Jean-Loup Chretien in 1988, is taking part in a 12-day mission with two Russian cosmonauts on board the Mir space station. They have been training for the mission since January 1991 in the prestigious "City of Stars," near Moscow, and their intensive preparations will enable them to perform the 10 experiments which are fundamental to the Antares mission. [passage omitted]

Michel Tognini will be spending 12 days on board the Mir station, twice as long as a "routine" visit to the Russian space station complex. The CNES [National Center for Space Studies] has paid 73 million French francs [Fr] for this flight, a bargain price which is surely the reward for long-standing French-Russian cooperation. After the mission, Michel Tognini will return to earth on the Soyuz TM-14, accompanied by Viktorenko and Kaleri, leaving Soloviev and Avdeieiv behind to act as the new maintenance crew. The cosmonauts on the Antares mission will certainly be kept busy: It is estimated that they will bring 12 kilograms [kg] of recorded information (on diskettes, cassettes, etc.) back to earth.

The Progress M-13 "space truck" was launched in June with a payload of 300 kg of equipment to pave the way for Tognini's mission. It transported an array of scientific equipment, including 170 kg of equipment needed for six biomedical experiments. Herein lies the essential aspect of the French astronaut's mission: to improve our understanding of how human beings function, not only in space, of course, but also on earth, by comparing the body's performance when subjected to or freed from the force of gravity. The mission also provides an opportunity to contradict the conventional wisdom. Having sent some 270 men and women into space, it is generally thought that the effects of weightlessness on the body are now well known. Yet this is simply not the case, primarily because the effects of weightlessness vary from subject to subject.

"Ultrasound," the first of the six biomedical experiments that Tognini will perform, will aim to study the cardiovascular system under conditions of weightlessness. This experiment will enable Prof. Leandre Pourcelot from Tours to continue the research he began during Jean-Loup Chretien's flight. The principal of ultrasound experiments is well known. Ultrasound-emitting electrodes are attached to the body and the organs are studied on the basis of the returning echoes. The "Ace of Hearts" is very-high-performance ultrasound device created by Matra as the latest in a line of increasingly sophisticated machines.

One difficulty of biomedical research on man is the fact that the body's time constants vary widely depending on the function involved. Some adaptations to weightlessness are almost immediate, they appear within the first few minutes of the flight. Others only emerge after several days, as is the case with the cardiovascular system, which can only be properly studied during a flight lasting one or two weeks. It is well known that the absence of gravity leads to influx of blood into the upper part of the body. This causes swelling of the face and profoundly affects the blood pressure in almost all parts of the body.

Under conditions of weightlessness, the heart does not have to work as hard, since the body is no longer obliged to operate the muscles which, on earth, allow us to stand up. In a gravity-free environment, the body reacts in a complex way before adapting. Perhaps Michel Tognini's trip will enable us to better analyze the hormonal processes by which the body adapts to weightlessness, as well as their effects: a drop in both the ADH (antidiuretic) hormone and aldosterone, which inhibits thirst whereas increased elimination of water and electrolytes is registered.

The second biomedical experiment, named "Orthostatism," is being conducted by Dr. Gharib from the Les Granges-Blanches Faculty of Medicine in Lyons. This too will be the continuation of previous research aimed at understanding how and why man manages to find his bearings in the absence of gravity. Indeed, what is this sixth sense, so rarely mentioned in the past, which under normal terrestrial conditions provides us with a genuine internal reference system? It is extraordinary to think that until the space age, the question had barely been raised. When we turn our head, we have the impression that our external surroundings are moving. The reason for this is the presence in our inner ear of a subtle system of otoliths constituting a veritable inertial platform. Since this platform no longer functions in a weightless environment, the body immediately begins looking for

something else, but it takes two to four days to liberate the sense of sight from its subservience to the inner ear. It is this relatively rapid process that the Orthostatism experiment intends to study. Afterwards, an attempt will be made to reconstruct how the body adapts to its new environment.

The third biomedical experiment concerns immunology; it is conducted within the scope of a cooperative project involving Dr. D. Schmidt of the Faculty of Medicine in Toulouse and Dr. I. Konstantinova, a leading Russian specialist in studies on immunology and weightlessness. The field of research in this area is vast. The extraordinary complexity of our immune system has been revealed to us over the past 20 years. Our body is capable of fighting the bacteria and cells which try to invade it in different ways: First, by means of lymphocytes produced by bone marrow while, under the influence of blood proteins, the invaders are incited to self-destruct. Second, the cells known as T-cells act as killers, piercing the membrane of foreign cells by means of a protein called perforin. Then there are B-cells, which produce the antibodies specific to the invader, via the lymphocyte interleukin from 400 links of DNA.

Our immune system also contains a veritable model of the aggressions which threaten us, following the example of our brain's representation of the outside world. Many specialists feel that the immune system has a higher connectivity level and greater cognitive capacities than the brain. We now know that it has a memory, in the sense that T- and B-cells remain on call after an alert. Experience has shown that this system is greatly disrupted in the absence of gravity. The immunology experiment will therefore attempt to study the immune system's "primary disorientation" in a weightless environment, which causes the body's acute sensitivity (justifying the precautions taken to prevent any contamination of astronauts) while it is in the process of adapting itself to the new circumstances.

Lastly, three other experiments will complete the biomedical research. "Illusions" will study the adaptation of sensorimotor functions in a weightless environment. What representation will we make of our bodies when we are stimulated by sensors attached to our shoulders, elbows, or knees? "Viminal" will continue the research begun in 1988 to analyze changes in cognitive functions under conditions of weightlessness. Does the brain work in exactly the same way on earth as it does in space? And the final puzzle will be to ascertain the size of the dose of cosmic radiation received by each astronaut. This will be the subject of "Nausicaa," the sixth biomedical experiment, which will involve studying the effects of cosmic radiation on a biological dosimeter.

The second area of study for this mission is materials sciences, a field in which microgravity makes for particularly interesting experimental conditions. As part of the cooperation between the Center for Nuclear Studies in Saclay (Dr. D. Beyssen) and the RERS in Moscow (P. Koutsikides), the "Alice" experiment will first study fluids which are nearing their critical point. This is the point on a phase plot of a body which ensures an equilibrium allowing solid, liquid, and vapor to coexist. Paradoxically, this equilibrium is difficult to achieve in an earth-bound laboratory, or it can only be achieved for minuscule volumes. Once gases support their own weight, pressure rises inevitably as one nears the lower part of the container.

In space, the critical conditions can be met inside an area in which the reversible transformations undergone by molecules during a phase shift can be studied. Numerous changes can be observed showing shifts in both directions between all the phases. Even then, the work must be performed in regions where the gravity gradient is considered weak enough to allow the pressure to remain nearly independent of altitude.

The second experiment in materials sciences is called "Superconductor." It is being conducted primarily by French researchers G. Collin from the CEN [Nuclear Research Center] in Saclay, C. Dembinski from the CRPTH of the CNRS [National Scientific Research Center], J.P. Chaminade from the Laboratory of Mineral Chemistry in Bordeaux, and M. Noel from the Laboratory of Mineral Chemistry in Rennes. Superconductivity is the property of certain metals—especially remarkable alloys containing copper, barium, and yttrium—whereby their electrical resistance is virtually nonexistent below a certain temperature. The reasons for this are still not fully known, even though the Cooper pair model (which suggests that for paired electrons, matter becomes virtually transparent) could serve as an excellent starting point for interpreting this remarkable phenomenon, which would have tremendously wide applications if it were not for the low temperatures required by superconductivity.

Over the past 20 years, however, impressive progress has been made toward the final goal of superconductivity at room temperature. From this point of view, the study of the formation of superconducting crystals in microgravity could provide extremely important information. Finally, a payload of 31 kg was set aside for conducting technological experiments using two different instruments. The first, a "Microaccelerometer," was designed by the CNES under the direction of J.P. Granier and Y. Dancet. An ultrasensitive acceleration sensor, which has virtually no inertia thanks to the extremely low mass of its active component, will provide a vibratory map of Mir. This will provide space station designers with information on the mechanical resonance phenomena which are likely to be encountered in a weightless environment and could cause premature wear of some parts of these facilities. The other technological experiment is called "Exeq." It was designed by researchers M. Romero and D. Falguere from the Center for Radiation Studies in Toulouse and can be considered a technological reply to the Biostack experiments carried out in the past by Apollo missions. Those experiments were aimed at ascertaining the biological effects of heavy ions in cosmic radiation, which turned out to be considerable.

All of these experiments, which have become routine for the cosmonauts who conduct them aboard Mir, will generate vast mountains of data that will take French and Russian teams years to decipher.

German Engineers' Association Publishes on Spacelab Mission Study

92MI0677 Bonn TECHNOLOGIE-NACHRICHTEN MANAGEMENT-INFORMATIONEN in German 10 Jul 92 pp 8-9

[Text] When funding space, biotechnology, or nuclear fusion projects, the BMFT [Federal Ministry of Research and Technology] carries out complementary technology impact assessment, with the purpose not only of comparing intended aims with actual results, but also of evaluating the potential and the risks arising from the technical development concerned. The arguments registered both for and against then provide an objective basis for public debate.

One example of these studies is the present technology impact assessment of the German Spacelab missions, just submitted by the VDI [Association of German Engineers] Technology Center. Unlike the previous Preliminary Study for Impact Assessment of Hypersonic Technology, this second study concerns an ongoing project under the American Space Shuttle Program. It thus both provides scope for comparison with results already available (e.g., SL-1, D-1) and outlines prospects for future German and European space projects that will succeed the Spacelab missions.

In addition to reviewing the historical development of previous Spacelab missions, the technology impact assessment study on the D missions provides detailed insight into the aims of interviews with experts and extensive analysis of relevant literature. For example, it reveals that 72 out of the scheduled total of 76 experiments have been successful, representing a success rate of around 95 percent.

The D missions will form the basis for further projects, to be known as E missions, to be undertaken by the European Space Agency (ESA). There has been a shift of emphasis in the experiments from the D-1 mission, which concentrated on basic research issues, to the planned E missions. D-2, and to an even greater extent the E missions, will be increasingly concerned with automation and telematics (experiments, or even repairs in space controlled from the ground) for future space missions.

The ultimate medium-term purpose of the E missions is to lay the groundwork for using the European space station COLUMBUS.

The study is not, however, concerned only with technological analysis as such, but goes beyond this to consider basic issues of space flight. For example, it examines arguments for and against space flight, both in general and with particular reference to manned flight. One argument in this connection is the fear voiced by some scientists that the considerable expenditure on space flight might deprive other research fields of adequate funding, especially as German space funding derives from the BMFT's budget, which is not the case in other countries.

As regards the current debate on space flight, it was shown that, while many of the arguments, both for and against, can be verified empirically, this frequently sanctions unwarranted generalizations, making it even harder to reach a consensus and pointing to the urgent need for future space technology impact assessment.

The study also concludes that, from the technology impact assessment point of view, there are no major objections to the D-2 mission scheduled for 1993. It is stressed that future space flight is of particular significance to developments in automation, robot, and telescience engineering. Although questions regarding the purpose and usefulness of manned space flight remain open, telecommunications, earth observation, and navigation provide three undisputed arguments in favor of space flight in general.

The study is available on written request to the Project Manager, Technology Impact Assessment, at the Federal Ministry of Research and Technology. Further information is available from Dr. A. Zweck, Project Manager for Technology Assessment, VDI Technology Center, Graf Recke Str. 84, 4000 Duesseldorf 1.

BMFT Funds Construction of Aircraft for Research in the Stratosphere

92MI0678 Bonn TECHNOLOGIE-NACHRICHTEN MANAGEMENT-INFORMATIONEN in German 10 Jul 92 p 9

[Text] A total of 80.4 million German marks [DM] has just been approved for construction of a new research aircraft, STRATO 2C, intended for stratospheric research at altitudes of 12 to 24 kilometers. European scientists have not hitherto had their own aircraft for gaining this altitude, which is crucial to atmospheric and climate research—for example, the stratospheric clouds that are central to the ozone layer problem are formed at this height.

The aircraft will be 22.4 meters long and 7.2 meters tall, with a wingspan of 56.6 meters, comparable to that of a jumbo jet. It will be capable of 48 hours of continuous flight at an altitude of 18 kilometers, and have a range of over 18,000 kilometers. It is claimed that it will be able to maintain an altitude of 24 kilometers for eight hours to carry out a series of scientific tests in the stratosphere. Depending on the mission, its payload will be in the range of 800 to 1,000 kilograms, with space for up to two scientists in addition to the two pilots.

If construction of this probably unique twin-engined research aircraft made of the latest plastic and carbon-fiber materials, goes according to plan, it will be able to

take off for its first survey from the German Aerospace Research Agency [DLR] airfield in Oberpfaffenhofen in 1995.

The new research plane will be used to study the chemistry and dynamics of the stratosphere, aspects of climate research (particularly interchange processes between the troposphere and the stratosphere) above Europe and tropical regions, and the interaction between the atmosphere and the biosphere. Other uses for the STRATO 2C will include meteorology, environmental protection, and the EC environmental research program.

The plane will also undertake aviation-related research: Flying at these altitudes, it will be able to assess the retention and spread of aerospace pollutant emissions in the upper atmosphere, and their effects on trace gases and the earth's radiation budget. Such studies would be an important contribution to the Pollutants in Aviation research program launched by the DLR.

A STRATO 2C Scientific Committee has been formed to coordinate the STRATO 2C program, which involves not only the aircraft's development but also its operation to the year 2000. The committee is currently devising the first draft mission programs and proposals for major measuring equipment acquisitions.

The BMFT plans to provide a total of around DM122 million to implement the STRATO 2C program, including developing the aircraft, fitting it out with measuring instruments, building a hangar and user facilities, and operating costs to the year 2000. A further DM20 million are also earmarked for developing scientific measuring instruments and for data evaluation.

Airbus A321 Reaches Final Assembly Stage

92BR0693 Paris SCIENCES ET AVENIR in French Aug 92 p 11

[Unattributed article: "First A321 Will Take Off in March 1993]

[Text] Final assembly of the first Airbus A321, the stretch version of the A320 (7 meters longer), has just begun in Hamburg. On 15 June, the German plant received the first set of wings from Bristol, which were reinforced to match the future aircraft's weight, which is higher than that of the A320 (which is assembled in Toulouse). The first A321, which should take off in March 1993, will be fitted with V.2500 engines from the IAE [International Aero Engines] consortium. A second A321 will take off two months later, fitted with CFM-56 engines (SNECMA [National Company for Aircraft Engine Studies and Construction]/General Electric). The first two airlines to receive the A321 will be Lufthansa (the V.2500 version) and Alitalia (the CFM-56 version), which will take delivery of their aircraft in early 1994. The A321 (186 passengers) will thus join the A320 (150 passengers) in the fleets of these airlines.

Airbus Industrie, which to date has sold more than 650 A320s and nearly 150 A321s, making a total of 800 aircraft from this family, will soon be expanding this range with the probable launch by the end of the year of the "short" version A319, a plane which seats only 124 people, but costs considerably less (under $35 million compared to $41 million for the A320). In actual fact, Airbus Industrie is already assured of selling more than 1,000 aircraft from the A320/A321 family. With the A319, which will allow the European consortium to find new customers and thereby increase its market share, Airbus Industrie will stand alongside Boeing (B737 family) and McDonnell Douglas (Super 80 family) in the 100 to 200-seat aircraft sector. In the other sectors (200-300 seaters and long-haul aircraft), the battle for sales is well under way, thanks to the Airbus A300, A310, A330, and the four-engine A340. Airbus Industrie reported considerable "book profits" of $100 million in 1990 and $207 million in 1991, making it difficult for American manufacturers to accuse Airbus Industrie of building airplanes at the taxpayers' expense, and to oppose Airbus sales around the world.

Germany To Build High-Altitude Research Plane

92WS0695B Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 2 Jul 92 p 8

[Unattributed article: "Bonn Intends To Build High-Altitude Research Plane: Wingspan Like a Jumbo/ Lightweight Construction With Carbon Fiber Materials"]

[Text] Bonn (dpa)—The Federal Ministry for Research has cleared the way for construction of a supermodern high-altitude research plane. For the first part of the program, 80.4 million German marks [DM] have been approved initially. According to the Ministry, the plane is to be used at altitudes from 12 to 24 kilometers. This range is particularly important for atmosphere and climate research. In the past it has not been directly accessible to European scientists with their own aircraft.

The project under the name "Strato 2C" plans to be ready for operation in 1995. Flights during hurricanes and over the polar region are supposed to be possible with the plane. As Federal Research Minister Heinz Riesenhuber stresses, Strato 2C will be far superior to the only stratospheric research plane to date, the ER-2 of the American space agency NASA. The ER-2 is the civil version of the U2 military reconnaissance plane.

Modern synthetic and carbon fiber technology are to be used in the two-engine German plane. The 56.6-meter wingspan is comparable to that of a jumbo jet. Strato 2C will reportedly fly for 48 hours without interruption and can thus cover 18,000 kilometers.

The first test flights will be based at the airport at the German Aeronautics and Space Research Institute (DLR) in Oberpfaffenhofen. Through the year 2000,

Bonn intends to provide the project with approximately DM122 million including operating costs.

No Need for Saenger Space Plane Seen

92WS0695C Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 3 Jul 92 p 8

[Unattributed article: "'Saenger'Is Not Needed in the Foreseeable Future: TAB: Not an Economic Alternative Until Exploitation of Mars and the Moon for Energy and Raw Materials"]

[Text] Bonn (AP)—The German project planned under the name Saenger for a horizontal takeoff, reusable space plane has no justification for its existence in the foreseeable future of space travel. This conclusion was reached in a study by the Bundestag Office for Assessment of the Consequences of Technology (TAB). As the head of the office, Prof. Herbert Paschen, explains, the implementation of the Saenger idea would require a basic decision for a very intensive exploitation of space, which includes, for example, energy production in space and mining of raw materials on the moon and Mars.

Paschen's justification of his assessment includes the reference to the fact that a maximum of 15 flights per year—for which the current system would suffice—would be needed to service the planned international space station Freedom and other possible stations. With estimated development costs of 45 billion German marks [DM], more than 20 flights per year would be necessary to make Saenger as cost effective as the European Ariane V rocket, for example.

Saenger is a pilot concept funded to date with approximately DM200 million by the Federal Ministry for Research for development of aircraft technologies for more than five time the speed of sound. The project is currently in the first stage of a pure technology program whose three-year extension through 1995 is to be decided this year.

In the two-stage, fully reusable system, ideally, the plane can take off and land at normal commercial airports using air-breathing engines. At 6.8 times the speed of sound at an altitude of 37 kilometers, the upper stage is sent with rocket power on its way into space. Whereas the lower stage lands normally, the upper stage returns to earth later as a glider—like the American space shuttle.

According to the conclusions of the study, use of hypersonic technology for commercial aircraft would fail for both economic and ecological reasons, because this air travel would have to take place in the ozone layer. As a space flight system, it would be less environmentally sound than current systems. Also, it is pointed out that concepts similar to Saenger which are possibly even more environmentally compatible are being developed abroad.

TAB proposes three alternative decisions to the Bundestag:

1. A three-year funding moratorium for hypersonic technology by the Federal Ministry for Research. During this period a basic decision is to be prepared and then made as to whether Germany wishes to continue work on such intensive exploitation of space that would make Saenger worthwhile.

2. Continuation of Phase I of the Saenger concept through 1995 for clarification of remaining technological questions, positive basic decision for more intensive exploitation of space and transition into Phase II for experimental implementation of critical technologies in international cooperation.

3. Preliminary tasks for definition of the Saenger concept and transition into a broadly designed program with basic investigations of critical technologies. The objective of this program should be a comprehensive comparison of various space travel systems for the future.

France Favors Second Helios Launch

92WS0703A Paris AFP SCIENCES in French 25 Jun 92 pp 6, 7

[Unattributed article: "France Favors Launch of a Second Helios Satellite"]

[Text] Cannes—France favors placing a second Helios military observation satellite in orbit after the launch of the first one in 1994, Aerospatiale informed us on 24 June. It has begun negotiating the change with its foreign partners in this program, Italy and Spain.

The Helios program originally called for the construction of a launcher, a satellite for placement in orbit, and a second, "backup" satellite which would remain on the ground. France (MATRA and Aerospatiale), Italy (Alenia), and Spain (CASA) [Construcciones Aeronauticas S.A.] have a 79 percent, 14 percent, and 7 percent stake in the program, respectively.

Impressed by the war against Iraq with the importance of military satellite intelligence and the need to have a minimum level of resources in order not to depend exclusively on the Americans, these three European countries may give new impetus to the first European military satellite program. According to Aerospatiale, this would mean speeding up construction on the second Helios satellite, which could be finished by 1996 at the earliest, and deciding to launch it instead of leaving it on the ground. Should these decisions be taken, the three countries will have two Helios satellites (8 billion French francs [Fr] each) in space at the same time for several years (they have a lifetime of no more than four or five years).

While awaiting the upcoming enactment of a military programming law, Aerospatiale is targeting 2002 for the

completion of two other, new generation Helios satellites, equipped with infrared cameras. The first two Helios are purely optical.

Aerospatiale is also targeting 2002 for European construction (necessary because of the cost) of an observation radar dubbed Osiris. Discussions are said to be underway among France, Italy, Spain, and Germany. A wholly French military telecommunications monitoring satellite called Zenon (Fr3 billion) is also planned for 2002.

In addition, Aerospatiale said on 24 June that it had approached the Ministry of Defense regarding the construction of an early warning satellite with infrared equipment. The purpose of the project, which would take four to five years, would be to monitor the world's proliferation risks.

Aerospatiale Determined To Develop Regioliner

92WS0703B Paris AFP SCIENCES in French 18 Jun 92 p 10

[Unattributed article: "Aerospatiale Will Not Abandon Its 90- to-120-Seat Aircraft Projects"]

[Text] Berlin—Aerospatiale still hopes to be able to put together a grand, four-way joint venture in the regional transport sector that would include its Italian partner Alenia, the German manufacturer Deutsche Aerospace (DASA), and the Dutch Fokker. However, "come what may, the French group will not abandon the 90- to-120-seat aircraft niche," Aerospatiale's president, Mr. Henri Martre, said on 15 June. "If Fokker persists in wanting to exclude Aerospatiale and Alenia from the four-way alliance, then it will be responsible for the failure of the alliance," Mr. Martre added from the sidelines of the opening of the Berlin air show, ILA '92.

Fokker's president, Mr. Nederkoorn, has repeatedly stated his opposition to allowing a Franco-Italian stake in the firm alongside the German DASA. According to Mr. Martre, it is not known whether DASA will bend to the Dutch injunction. "We are trying to reach a compromise, but it is very difficult in view of Fokker's position."

Without resigning himself in advance of the failure of the great coalition, the president of the French group indicated that he was not worried about the group's future: "If DASA is reduced to breaking off its negotiations with Fokker and staying with us, we will carry out the tripartite (DASA-Aerospatiale-Alenia) Regioliner projects we had planned, that is, a 92-seat aircraft and a 122-seat aircraft. On the other hand, if DASA gives in to the Dutch injunctions, the Franco-Italian joint venture that was established for the ATR will develop its own project, possibly by forming other alliances."

The Franco-Italian alliance already makes the ATR-42s and ATR-72s (50 and 70 seaters) and has a twinjet ATR-82 project in its files that could occupy the 90-seat jet engine aircraft niche. ATR's general manager, Mr. Henri-Paul Puel, said a year ago at the Le Bourget show that he was holding on to this project "just in case."

Moreover, a scale model of the ATR-82 was presented at the Berlin show "in order to test the market," according to Mr. Martre's entourage. Derived from its ATR-42 and ATR-72 predecessors, this twin turboprop would compete with the future Fokker-70 in the event of a German-Dutch alliance.

ATR already has an agreement with CASA for the Regioliner projects, which would make the Spanish manufacturer a partner of choice for any new joint venture. "But," Aerospatiale's president indicated, "we are not excluding anyone in the regional transport market: the Czechs, the Chinese, the Taiwanese—or even British Aerospace, which has just launched its own project for a line of 80 to 120 seaters."

Germany, Japan To Collaborate More Closely on Space Research

92MI0707 Bonn DIE WELT in German 28 Aug 92 p 13

[Text] In the opinion of Federal Research Minister Heinz Riesenhuber, the effect of the current financial crisis and short-term revenue and profit losses on the competitiveness of Japanese companies should not be overestimated. Pressure for rationalization, coupled with an innovatory thrust that remains as strong as ever, flanked by research promotion strategies on the part of the government, could mean the Japanese economy emerging strengthened from the current crisis.

The Japanese challenge would therefore remain, if not actually increase, in the high-tech fields and the very sectors that are important to the German economy. German industry should recognize and exploit the opportunities held out by the Japanese market and collaborating with Japan. The motto would have to be: "Presence in Japan." Strategic joint development ventures would be the best policy, said Riesenhuber yesterday in Tokyo. The Minister is visiting Japan from 22 to 29 August, discussing German-Japanese cooperation in research and technology with his Japanese counterpart, Kanzo Tanigawa.

In the view of the two ministers, astronautics could represent a particular area of emphasis for cooperation. The German Space Agency DARA and its Japanese counterpart NASDA will investigate the potential for working together, particularly on earth reconnaissance and environmental research, automation and robotics, and the further development of transport systems.

Now that a joint five-year research program on materials research and life sciences under space conditions has been agreed upon, scientists from both countries will start on experimental programs at the microgravity

tower in Bremen and the Japanese microgravity shaft at Hokkaido, and will make joint preparations for space station use.

The German and Japanese partners have also agreed to intensify discussions on future joint strategies for further advancing space developments. Particular importance is being attached to the joint development and exploitation of a recoverable capsule (EXPRESS) designed to obtain pertinent information, including reentry technology developments by the Commonwealth of Independent States, that is not yet available to Japan and Europe.

Manufacture of Airbus A321 in Hamburg Described

92WS0715A Frankfurt/Main FRANKFURTER ALLGEMEINE in German 7 Jul 92 p T4

[Article by Dieter Vogt: "The Hamburg Airbus Takes Shape"]

[Text] It will not be able to fly for a long time yet, but it already has wings—they were just mounted. The most recent Airbus is taking shape. At the edge of Hamburg, in the 300-meter-long Otto Lilienthal Hall at German Airbus GmbH in Finkenwerder, assembly of the short- and medium-range A321 jet has begun. This is the stretched, slightly modified version of the successful A320, which is considered the trailblazer of new technology in aeronautics. More than 300 aircraft of this type are in use all over the world.

The German aircraft builders count it as an industrial policy success to have gotten Hamburg accepted as a second final assembly plant in addition to Toulouse. They did not have an easy task, primarily with their French partners. For 20 years the city in southern France has been the only Airbus assembly center: a prestige location for the aerospace industry. The 890 aircraft delivered so far of type A300, A310 and A320 all came from Toulouse. The fact that not merely components but, as in the old days, complete commercial aircraft are to be built along the Elbe, was greeted with enthusiasm in Hamburg. "The start of the final assembly has begun a new chapter in the history of European aircraft building," said German Airbus chief Hartmut Mehdorn. "Integrated final assembly of the A321 in Hamburg makes the Airbus program more economical and is an expression of visible, more intensified cooperation by the partners."

An assembly line with eight work stations through which the growing aircraft passes was chosen for the A321. Here the tail is being put together, there it is fitted with everything the European partners have preassembled: the airfoils from England, the forebody with the cockpit from France, the elevator assembly from Spain and multiple assemblies from Italy, Belgium and Japan. Large sections of the fuselage come from German production, as well as the tail and rudder units.

The first Airbus A321 will receive its engines in October, it will leave the assembly hall in March 1993 and shortly thereafter start on its maiden flight. After a 750-hour test program involving four aircraft, the newcomer will receive its certification as early as December 1993. Immediately after that, around the turn of the year, the first A321 will begin regular service under Lufthansa's colors. The German airline will buy 20 of the jets. Alitalia could become the principal customer with an order for 40.

Just like its little brother the A320, the A321 has a computerized two-man cockpit and electric flight controls ("fly-by-wire"). Common to both is also the widespread use of new composite materials for supporting structures such as horizontal and vertical tail units. The material weighs less and can be processed faster than aluminum alloys, thus saving both weight and construction time.

The Airbus A321 will transport 180 to 200 passengers on routes up to 4,000 kilometers. Just as for the A320, two economical turbofan engines with about 13,600 kp thrust are available: the CFM 56 (General Electric, Snecma) and the IAE V2500 (Pratt & Whitney, Rolls-Royce, MTU, Fiat). At this time 144 orders have been received for the new 80-ton aircraft, which is 44.5 meters long, not quite seven meters longer than the A320. Two aircraft a month in 1994 and as many as five aircraft a month in 1996 will be produced in Hamburg. The time from receipt of the first components to delivery of the painted, completely equipped and, of course, tested aircraft to the customer will be no more than 46 days.

Deutsche Airbus GmbH has invested a great deal in its plant in Finkenwerder in order to meet the greater demand. The existing runway was extended by 400 meters to 2,328 meters for the imminent factory test flights. In addition to the new Otto Lilienthal Hall (not quite 30,000 square meters) a so-called flight delivery building (5,300 square meters) is being built, in which later on the fleet directors of the airlines can take delivery of their aircraft.

Things will happen around the plant as well. The aircraft builders anticipate that small and medium-sized suppliers will settle in the vicinity of the assembly center, as was observed in Toulouse as well. Two companies are already there. In the long term one is also prepared for a moderate change in the industrial landscape of southwest Hamburg. Last year more than 6,000 supply companies worked for Deutsche Airbus GmbH.

Stretching the A320 into the A321 is not the last step on the road to an entire family of closely related aircraft with a standard fuselage. The European Airbus consortium, the second largest aircraft manufacturer in the world after Boeing, will next build a shortened A319 as well, which has seven ribs fewer and space for only about 124 passengers. The smallest Airbus will also spread its

wings in Hamburg. It is designed according to a "minimal change concept," which requires as little intervention into the A 320's structure as possible, but still entails development costs amounting to $275 million. The Airbus threesome will thus meet every demand ranging from 120 to 200 seats, so that customers can save themselves the trouble of going to U.S. competitors Boeing or McDonnell Douglas. That is the hope at Airbus.

Larger Engines Planned for Ariane V Launcher

92WS0720A Stuttgart FLUG REVUE in German Jul 92 p 24

[Article by Goetz Wange: "Higher Performance for Ariane;" first paragraph is FLUG REVUE introduction]

[Text] SEP is celebrating the delivery of the 500th Viking rocket motor for the Ariane rocket. The joy is clouded by the German reserve about the Vulcain Mark II.

You should really celebrate occasions when they occur. But that was not possible for the celebration honoring the production of the Ariane rocket motor. The 500th Viking thrust chamber, which will be used in both the first and second stage of the Ariane 4 rocket, was already delivered in the fall of last year. But since the prominent politicians could not be brought under one roof, and furthermore there were regional elections to take into account, the celebration was postponed until 19 May.

So what was rolled out in front of the invited guests was in fact already motor number 533. But never mind. Jean Sollier, president of SEP, could justifiably be proud of his Viking team's work. In addition to the French, it is primarily German MAN and Sweden's Volvo which are participating.

While French Research and Space Minister Hubert Curien used more diplomatic expressions in his celebration speech, Charles Bigot, chairman of the board of the marketing and operating company Arianespace, came right to the point: "Ariane's success is based in its ability to carry two satellites into orbit at the same time. That is why even now programs must be initiated to increase the performance for the Ariane 5," he stated to FLUG REVUE.

This request is justified with the tendency toward higher satellite weights. So far the Ariane-5 has been designed so that after 1995 it will be able to transport two satellites of 2,950 kg each into a geostationary transfer orbit. Meanwhile, however, U.S. competitor General Dynamics has continued to develop the Atlas rocket. The Atlas IIAS version will be able to carry a 3.7-t satellite from Cape Canaveral.

"Until now it has always been like this: When rockets get more powerful, the weight of the satellites also increases," explained Roger Vignelles, program director for SEP. "If Ariane wants to continue to utilize the double launch as a market advantage, then Ariane 5's capability after the year 2000 will have to be about 15 percent higher than now."

This will primarily be realized by improving the Vulcain motor. Corresponding studies under the title of Vulcain Mark II have already been made. They are aimed at increasing the fuel in the central stage from 155 t to 170 t and raising the ratio from 5.3 to 6.2. In order to achieve a higher flow-through rate for the liquid oxygen, the LOX turbo pumps will have to be modified.

The higher operating temperatures created by this are not without problems. For that reason the exhaust nozzle, for example, is to be made of ceramics. All measures together lead to a performance increase for the Vulcain rocket motor from 1,120 kN at present to 1,300 kN, whereby the specific impulse will be increased by two seconds to 434 seconds. Despite the improvements, SEP wants to deliver the Mark II motor at the same price.

All in all, the program will cost about 1 billion German marks [DM]. A development period of five to six years will be allocated. A decision within ESA [European Space Agency] would therefore have to be made in 1994.

The French plans have so far fallen on deaf ears in Germany. "That is not unusual. When Ariane 1 was to be improved to Ariane 2/3, it was also said in Germany that the rocket was overdimensioned. But now the trend is toward greater satellite weights," comments SEP manager Vignelles calmly. "Without increasing performance, Arianespace would have to undertake more individual launches, which would be less effective, of course."

But in order for everything to be developed according to schedule, technologies will have to be worked out even before ESA's decision. This preliminary program will be financed out the national space flight budgets. According to information from SEP, agreement in principle has been received from France, Sweden and Italy. In Germany, due to the precarious financial situation, one is not prepared to discuss it. The share needed would be DM12 million annually for three years in a row.

SEP has also examined whether the know-how of the Russian rocket builders could be used. The answer was negative. "They build good, large rocket motors, as far as power is concerned," in Vignolles's opinion. "But these designs cannot be cost-effectively built. That is too expensive for non-recoverable motors."

BMW-Rolls Royce Developing New Jet Engines

92WS0720B Stuttgart FLUG REVUE in German Jul 92 pp 26-27

[Article by Volker K. Thomalla: "Igniting Idea;" first paragraph is FLUG REVUE introduction]

[Text] The young BMW-Rolls-Royce enterprise is turning into a trendsetter in the race for a future short-haul engine. The core of the BR700 family is to be fired up next year on the test stand at the research center at the new Dahlewitz location.

Approximately 1,100 employees are working for BMW-Rolls-Royce at the three Oberursel, Bristol and Lohof sites, and their number will grow to 2,000 by the end of the 1990s. BMW AG owns the largest share of 50.5 percent, and 49.5 percent are held by British engine manufacturer Rolls Royce.

BMW-Rolls-Royce wants to build three engines for regional and business jets: The BR710 turbofan with a takeoff thrust of £10,000-15,000 (44.4 to 66.7 kN), the BR715 with 14,000 to 22,000 (62.27 to 97.85 kN) and the BR720 as the family member with the highest thrust, whose value has not yet been determined. All three engines will have the same core engine. Rolls-Royce stresses that the core was designed from the beginning to be a purely civilian core engine and not, as its potential competitors, derived from a military application. As a high-pressure core it is conceived for use at speeds around Mach 0.85 and altitudes around 45,000 feet. The high-pressure compressor will have the relatively high pressure ratio of 17.

The development schedule for the new engines, which development chief Professor Guenter Kappler has put together, is ambitious: After the founding of BMW-Rolls-Royce on 1 July 1991, development on the core engine was officially begun as early as March 1991. It is to start up on the test stand during the first half of 1993. A development and test center will be built on a 30-hectare site just purchased in Dahlewitz south of Berlin, at which after the mid-1990s the serial-production engines will be assembled, tested and handed over to the customer. The company aims to have the engine licensed in 1996, so that it may be taken into service the following year.

BMW-Rolls-Royce intends to meet the demand for increasingly greater environmental safety of aircraft engines with more highly developed and affordable technology. One of the focal points of the development will be the wide chord fan, which, depending on the required engine performance, will have a diameter between 1,112 m (44 inches) for the BR710 and 1,397 m (55 inches) for the BR715. For the BR720 a larger fan diameter is required. The bypass ratio will be 3.9:1 for the BR710, and for the BR715, due to the larger fan diameter, 4.7:1. The slow-turning fan will serve, among other things, to keep the noise emissions of the BR700 clearly below the legal requirements then in effect.

The fan is connected—except for the BR710—to a booster, which is designed on the technology of the proven booster of the Rolls-Royce-Tay engine. Of the 10 stages of the compressor, the first four will have adjustable blades.

The development team around Professor Kappler wants to tackle other emissions that have entered the discussion, such as nitrogen monoxides or unburned hydrocarbons, with a new, low-polluting combustion chamber of the second generation, for which one has applied for a patent. According to information from Professor Kappler, it is a "circumferentially stepped combustion chamber, which adheres to the technology of the RB211 Rolls-Royce engine." It is being designed as a simple annular combustion chamber, while a double-ring combustion chamber is being worked on for research and demonstration purposes.

First Contracts With FADEC Have Been Signed

Naturally, the engine will be electronically controlled by FADEC, and the first contracts for development of the digital engine control have already been awarded to the BMW development center near Munich. For this BMW-Rolls-Royce is able to rely on experience collected by Rolls-Royce with the automatic control of its own engines.

All in all, the members of the BR700 family are to become engines, which have a 15-percent lower consumption and clearly reduced operating costs compared to today's engines. The compact design of the eight components—fan, low-pressure compressor, high-pressure compressor, combustion chamber and axle, bypass control, exhaust hole and transmission—further assures easy maintenance of the entire unit.

As potential applications for this family of engines, David Evans, the manager in charge of BMW-Rolls-Royce sales, mentions the upper segment of the business jets, regional jets with 60-140 seats and future military transports such as the EURO-FLAG project. For the Fokker 70 and McDonnell Douglas MD-95 the BR700 family is not an engine candidate, since it will be available too late and, furthermore, the Rolls-Royce-Tay is attempting to sell its engine for that, with which "one does not want to compete," according to Evans. For other projects such as the Canadian Global Express, the Fokker 130 and the planned regional liner family—if they are ever realized—the timing is excellent. The BR700 is also being mentioned as an engine for a potential Boeing 737 successor. At the Moscow engine exhibition in April various Russian construction firms showed keen interest in the BMW-Rolls-Royce product. Tupolev, for example, wants the BR715 as the engine for the Tupolev 334 twin-jet, a successor to the TU-134 tri-jet.

For the period 1996 to 2010, BMW-Rolls-Royce market studies have discovered a need for not quite 9,000 engines of this class. Evans envisions a market share of about 30 percent or, expressed in absolute numbers, approximately 3,000 engines. But with this number no sales are taken into account in the Commonwealth of Independent States (CIS) or for military applications. BMW-Rolls-Royce is talking with various other companies about a risk-sharing collaboration in the BR700

program, which is to amount to no more than 30 percent. "Without state support we are looking for a partner," according to Professor Kappler. The subsidy applications have been submitted to the responsible authorities, but in view of the empty public coffers it is questionable whether and how the program can be financially supported. As has been revealed, MTU in Munich—which together with Pratt & Whitney has itself been working on an engine of this class—has participated in the talks. For the time being, however, the exploratory talks, "in a friendly atmosphere," with this manufacturer who belongs to DASA [Deutsche Aerospace] ended without result.

Arianespace's Bigot on Competition, Prices, Strategy

92WS0720C Stuttgart FLUG REVUE in German Jul 92 pp 30-31

[Interview with Charles Bigot, CEO of Arianespace, time and date not given, by Goetz Wange: "'Discussion About Dumping Prices Is Difficult;'" first paragraph is FLUG REVUE introduction]

[Text] More than 100 customers have already placed their trust in the European Ariane rocket for their satellite transportation. But the competitive struggle is becoming increasingly tough. After China, Russia could now also enter the market with cheap prices. Arianespace, the operating company, is aimed at defending its position as market leader.

[Wange] Launch services for satellites are increasingly turning into a poker game with prices. Due to the order for a total of 50 rockets in one batch, it was possible to reduce the European space industry's production costs for the Ariane. How much margin has this given you?

[Bigot] We had tried to improve our production performance from several aspects. Among them were, of course, production costs as well. An important part of this was shortening the production cycle. By so doing, capital is not tied up any longer than absolutely necessary. Therefore, today we order an Ariane only 30 months before launch, while formerly it was about 44 months. Through major orders the industry was able to plan better, as well as conclude more favorable contracts with the subcontractors. All in all, the savings amounted to about 20 percent. Since everything is checked out once more in the course of optimizing the production runs, it was also possible to raise the quality.

[Wange] The improved calculation basis may possibly help to recapture lost ground. Nevertheless, two important contracts were lost because the competition came in cheaper: The German Federal Post Office chose the U.S. Delta for DFS-Kopernikus 3, and INTELSAT for the first time signed a contract for a launch with China.

[Bigot] Although the Ariane is considered the best launch vehicle in the world, I understand that INTELSAT follows a policy in which they rely on two launchers: At the moment Atlas and Ariane are used approximately to the same extent. INTELSAT signed a contract with the Chinese, to be sure, but no one knows what is really in it. Neither the payload nor a launch date have been determined. From my point of view, INTELSAT did not enter into an irrevocable obligation. It was probably more a matter of showing that there are still alternatives, just in case. As for the decision by the German Post Office, you will have to ask them why they preferred a U.S. rocket. We were surprised, since we had received a number of letters from the Post Office which gave the Ariane the highest praise.

[Wange] But does not this decision have a good side to it as well? If European governments place their orders in the United States, you could perhaps alter your policy, which until now has excluded contracts from the U.S. Government.

[Bigot] No. If anyone thinks so in Europe, he is naive. The Americans proceed very pragmatically. Their government does not want to use the Ariane because it is protecting its own industry. It has recognized that access to space has a strategic importance for the future. Therefore I am sure that there will be no change in the attitude toward the Ariane for a long time.

[Wange] In addition, the Japanese with their H-2 rocket are pushing into the commercial launcher market. If the newspaper accounts are correct, it turns out even before the first launch that the $65 million advertised production costs for the rocket will almost double. Does this relieve Ariane of the new competition to begin with?

[Bigot] I am not so sure. The Japanese have demonstrated with the successful start of the H-1 that they are capable of doing good work. After the period necessary for development and qualification, I see no reason why the H-2 should not work just as well. As for the indicated price, I have no information, of course. So I assume that in the foreseeable future the Japanese will become competitors to be taken seriously. After the maiden flight in 1993 or 1994, they will need another approximately 10 launches before they are fully operational. With a frequency of three to four launches a year, another three years will thus go by. Because in order to be considered sound on the market, you must first demonstrate reliability. Those who want to play cannot limit themselves to making promises and offering cheap prices.

[Wange] Are you primarily thinking of the Chinese?

[Bigot] Some people are so naive about this. The Chinese have not shown a thing yet. Of course they know how to build rockets and launch them—there is no question about that. But when you look closely at the balance of launches in five years, it becomes clear that so far they have not presented any proof of reliability. So what if they have a lower price.

[Wange] You have accused the Chinese of trying to obtain customers with dumping prices. What do you expect the Japanese to do in this respect?

[Bigot] Until now the Japanese have not really engaged in the competition. As far as I know, they were encouraged by INMARSAT and perhaps also by INTELSAT to submit bids. In general, it is very difficult to speak about dumping. My definition of dumping is to offer below your own costs. This presumes that you know your costs. But the Chinese have no idea of their costs. That goes for the Russians as well, by the way. But the Japanese are extremely profit-oriented business people, who surely will not sell below their production costs. But access to space has strategic importance. So if certain ground infrastructure facilities in some countries are paid by the government, this alters the competitive preconditions, of course. Dumping in the strict sense is not present, but the basis of calculation is more favorable.

[Wange] Does that not apply to Ariane as well?

[Bigot] Of course, but we put the facts on the table. We state to everyone that ESA [European Space Agency] paid for the development of the rocket and the initial investment. Arianespace takes over everything else, and it has to be recouped in the marketplace as profit.

[Wange] Some of the Russian rockets are now no longer needed by the military. Will that have any effect on the commercial market, too?

[Bigot] That question is difficult to answer. No one knows in which direction the countries of the former Soviet Union will move. No one knows what will happen in the next few months, much less in the next few years. Who wants to put hundreds of millions of dollars on the table to pay for a service, if it is not certain whether it will be provided in five years' time? Not too long ago they carried up to 100 launches a year. There is no question that they have a great deal of experience.

[Wange] So would it be conceivable that in the foreseeable future Russian companies could participate in the industrial consortium for Ariane or at least be considered as subcontractors?

[Bigot] In principle everything is possible. We will follow the developments in the countries of the former Soviet Union very attentively. But with the present conditions it is too early to have a realistic concept.

[Wange] One of the reasons for developing the Ariane 5 was the trend toward increasingly bigger satellites. Is this evaluation still correct today?

[Bigot] Yes. Over the next few years the telecommunications satellites will weigh in at between 2.5 t and 4.5 t, as a rule. None of that will change by the year 2000. Most satellites are right around 3 t. That is why Ariane 5 will be the ideal transport vehicle. Because two of these satellites can be sent into space per launch. Of course, greater transmission capabilities can be built into even larger satellites, which also means higher profitability. Because nothing important changes for the costs of the satellite bus. For that reason one may anticipate a further increase in satellite weight. So I advocate further development of the Ariane 5.

[Wange] Arianespace has also analyzed the market for minisatellites. With what strategy will Arianespace turn to this segment of the transportation market, and why was the cooperation with the U.S. manufacturer of the Pegasus system terminated?

[Bigot] We studied this area for two years. To begin with, it really looked as if it could become commercially interesting. Alternatively, we had our own European development of a small starter rocket and the partnership with OSC for Pegasus in mind. Ultimately it turned out, however, that commercial initiatives really exist only in one area: mobile communication. An example of this is the Iridium proposal, for whose implementation it is necessary to place a number of small satellites in orbit. When you study the matter more carefully, large launch vehicles turn out to be the most favorable solution. You can transport about 10 satellites at one time. By the way, this applies not only to the buildup phase of the system, but for launching the necessary replacement satellites, too. But nothing has been decided yet. The systems are still in the definition phase. And at present the minisatellites are getting bigger and bigger every month. You have to wait and see which transportation task will actually be the result.

German Government Calls for End to Uncertainty Over Major ESA Programs

92MI0721 Bonn TECHNOLOGIE-NACHRICHTEN MANAGEMENT-INFORMATIONEN in German 15 Aug 92 pp 9-10

[Text] Prior to the next ESA [European Space Agency] ministerial council meeting in November 1992, the federal government is calling for final decisions, especially on the major Columbus and Hermes projects, and the adaptation of future European space policy to bring it into line with new financial conditions and opportunities for international cooperation, thereby creating for all a reliable basis for planning over the years to come.

It is the declared aim of German space policy to continue participating in manned space flight projects. In this context, the federal government continues to set great store by close cooperation in Europe, and is holding to its agreements with the United States on participation in the Freedom space station as part of the Columbus project. In addition, collaboration on space matters with the CIS has increased since the political reforms in the former USSR. One important reason for holding to international space cooperation is that science and industry thereby preserve and extend their know-how in the relevant high-tech areas.

For its part, the federal government has made great efforts, despite all the financial burdens brought by the unification of Germany, to remain a reliable partner for the other countries in world space research. In 1992, it

has already increased its contribution to the ESA program to 1,133 million German marks [DM], which is DM169 million more than in 1991. It is envisaged that this sum will be further increased by DM100 million in 1993. In addition, medium-term financial planning makes provision for a further annual 2.5 percent increase in this appropriation, which must also cover inflationary risks. The BMFT [Federal Ministry of Research and Technology] is conscious of its responsibility for providing backing in other sectors too, including, in particular, the development of the research environment in the new federal laender. This means that spending on space travel must not be to the detriment of other areas requiring assistance. In the coming years, BMFT spending on space travel will remain below 20 percent of its budget (1993 budget appropriation: 18.9 percent).

Considerable progress has already been achieved in negotiations with ESA since the ministerial council meeting in November 1991. This progress includes agreement on the priority use of space technology for environmental research with, for example, a satellite mission, POEM-1, that has been declared a new major item in the ESA program. A further example of progress is the ESA proposal that the former long-term budget to be superseded by a graduated budget, the aim being to incorporate "projection milestones" for the content and objectives of the programs, which have hitherto been drafted on a very long-term basis. This would make it possible to minimize the budgetary and financing risks, shorten the operational targets, and, thanks to the opportunities for revision, introduce adjustments at an early stage.

There is also agreement on continuing with the successful scientific program (e.g., Giotto for comet research, Ulysses for solar surveying) with a 5 percent annual increase in finance until 1994, and on stepping up earth reconnaissance as a priority area (e.g., ERS 1 and 2). The unmanned part of the Columbus program will concentrate on polar platforms, while the manned part will initially concentrate on developing the laboratory module docked with the international space station Freedom, and on preparatory flights with Spacelab and Eureca. Here, Europe will fulfill its contractual obligations to the United States as regards joint work on the Freedom space station, together with Canada and Japan.

Further, there is agreement with the other European countries on continuing the Ariane-5 development to secure European market prospects for satellite launching services, and with it the relevant German industrial capacity. At ESA, there is also consensus that the Columbus subproject "Man-Tended Free Flyer II," together with development of the originally planned orbital glider Hermes, cannot be accomodated in the current financial and time frame until the year 2000.

With a view to the upcoming Granada conference, decisions are needed with the partner countries and within ESA in particular as to possible alternatives to an unmanned Hermes. In the view of the BMFT, this cannot be financed either under the prevailing conditions. ESA has proposed an unmanned Hermes demonstrator (Hermes X2000) as a first stage. At the ESA council meeting in Paris, Germany called for further options to be investigated, up to and including a Hermes technology program that would simultaneously make it possible to establish the basis for future transport systems, and to extend joint project work, especially with the CIS.

In order to exploit the savings potential to full, international cooperation with the United States and Japan should be stepped up, the BMFT believes. In addition, Federal Research Minister Riesenhuber intends to support ESA's plans to establish a joint program, extending over several years, with the CIS preparing the way to work with and become part of the ESA program and to make this a reality with all possible speed.

The current year had seen some convincing results in this connection: the participation of German astronauts and cosmonauts in an international Spacelab mission, IML-1, in January and in Mir '92 on 25 March 1992, the Giotto flight past the comet Grigg Skjellerup on 10 July 1992, the first mission of the recoverable space platform Eureca, which is expected to begin its full experiment sschedule in the next few days, on 31 July 1992, and the virtual completion of the preparation of D-2 for its launch in February 1993.

Further information on the views of the BMFT on the shape that the European Space Program should take in the future are contained in a BMFT document "Report on the Implementation of the Decisions of the Council of ESA Ministers Held in Munich from 18 to 20 November 1991, and Their Budgetary Implications," which can be obtained, free of charge, from the editor of TECHNOLOGIE-NACHRICHTEN.

German Role in Eureca Satellite Program Reviewed

92MI0722 Bonn TECHNOLOGIE-NACHRICHTEN MANAGEMENT-INFORMATIONEN in German 15 Aug 92 pp 11-12

[Text] After overcoming initial problems, Europe's largest and heaviest satellite, Eureca, achieved its operational orbit around the earth at an altitude of 525 km. The delay in performing the first transfer maneuver after the launch from Bilderbuch on 31 July was primarily due to calibration inaccuracies in the control software on the ground, which has since been successfully adapted.

On board, there are five multipurpose systems, in which 26 experiments will be performed, plus 10 individual instruments. German research institutes and industrial companies have provided five experimental assemblies, with the University of Freiburg alone contributing two

devices engaged in growing protein monocrystals, cadmium telluride monocrystals, and various semiconductor materials for new applications (PCF [Protein Crystallization Facility] and AFM [Automatic Mirror Furnace]).

One of the areas that the DLR [German Aerospace Research Institute] Institute of Biophysics in Cologne will be investigating with its multipurpose experimental system ERA [Exobiology and Radiation Assembly] is the effect of severe cosmic radiation on biological specimens. The University of Bochum's HPT [High Precision Thermostat] can also be used for several experiments to investigate the still unexplained behavior of liquids close to their "critical point." German Aerospace, DASA, is represented with the RITA [Radio Frequency Ion Thruster Assembly] technology experiment, which is intended to record the performance characteristic of this type of propulsion unit. The systems have all been produced and tested by German industrial companies, thereby demonstrating once again their international competitiveness.

The extension of the period available for experiments and tests on board Eureca under microgravity conditions will increase European research and industrial scientists' opportunities for experimentation. Previously, these have been restricted to the microgravity tower, parabolic flights, the research rocket Texus, and the slightly bigger version, Maxus, with experiment times ranging from a few seconds to several minutes. Experiments carried out on board the Spacelab, however, can last up to a week. With the operational phase of the Eureca-1 mission that is now beginning, Europe is for the first time in a position to conduct autonomous long-term measurements on materials science and biological specimens. This represents an important step forward in preparing for the Columbus space station program.

The platform can also be fitted out with extraterrestrial experiments and telescopes in subsequent missions. ESA [European Space Agency] is planning further flights by the versatile laboratory platform in the fall of 1995 and spring of 1998 (Eureca-2 and 3). In addition to further microgravity experiments, the main emphasis in provisional suggestions for experiments to be performed on these two missions is on extraterrestrial research. This includes solar and astronomical research, space dust and "space junk" observation, and various technical space flight experiments. Both flights are to be financed under the ESA program and made available for use by scientists. As soon as details of the flights have been decided, ESA will announce what opportunities there will be for participation by experimenters.

With an overall mass of 4.5 tonnes, Eureca, the heaviest satellite yet built in Europe, can carry a payload of one tonne. It has its own propulsion system (620 kg hydrazine), the main task of which is to carry it up to the operational orbit, return it to the orbit of the space transporter, and make orbit corrections if the mission is extended. Eureca is optimized for flights lasting from six to eight months but can remain in space for up to 18 months if it cannot be recovered by the space transporter according to schedule. The two extending and retracting solar cell wings supply 1 kW of power for the payload. The platform is designed for a total of five missions over a period of 10 years.

In the spring of 1993, Eureca will descend under its own power to an altitude of 315 km, where it will be taken back on board by the space transporter, and transported down to earth. On landing, it will be taken back to Europe, examined minutely, overhauled, and fitted out with a new payload for the second mission, planned for 1994-1995.

For the first time, complete responsibility for the mission lies with the ESA control center (ESOC) in Darmstadt. Germany has a 53 percent share in financing the Eureca program, including initial launching, amounting to 460 million German marks [DM].

The platform is financed by nine ESA member countries. Development started in June 1985 under the leadership of MBB-ERNO [Messerschmitt-Boelkow-Blohm Northern Development Group] (now ERNO Space Engineering, DASA) and was based on a tubular construction used in 1983 for the German automatic experimental platform, SPAS.

Numerous other European firms also participated in the program, principal among them being AEG (power supply), Alenia (temperature regulation), Matra Marconi Space (data processing), BPD (propulsion), Alcatel-Bell (communications), CIR (ground equipment), SENER (electronics), and Fokker (solar generators).

AUTOMOTIVE INDUSTRY

German Motor Industry Tests Hoechst's Ceramic Combustion Chamber Valves

92MI0728 Bonn DIE WELT in German 3 Sep 92 p 1

[Text] The constantly growing requirements for environmental protection are increasingly influencing developments in the automobile industry. Lowering pollutant emissions, reducing noise, and cutting fuel consumption are the main concern of the engineers. In developing and testing ceramic valves for piston engines, the Hoechst chemical company has for some considerable time been pursuing an important path in the direction of the environment-friendly internal combustion engine.

By providing access to the intake and exhaust manifolds, the valves control both the admission of the fuel/air mixture into the combustion chamber and the expulsion of the exhaust gases produced into the exhaust manifold. The valves therefore have to be extremely wear- and heat-resistant. After all, at an engine speed of 7,000 rpm, they have to execute an abrupt opening and shutting movement 3,500 times per minute. Whereas the stems of the valves remain relatively cool during operation, the

heads, being part of the combustion chamber, have to withstand temperatures of up to 900°C.

The low specific weight of ceramic valves, especially in comparison with the steel valves currently in use, makes them at least two-thirds lighter than their conventional counterparts. As a result, the valve spring can be smaller, and the valve can be shortened overall. Since October 1991, ceramic valves have been undergoing testing in regular fleet use at Hoechst AG.

The basic vehicle used for this is the Mercedes-Benz 300E with a six-cylinder, four-valve engine. After covering approximately 40,000 km on the road, this first vehicle gave such good results that a second vehicle of the same type has now been brought into service with ceramic valves. It is planned that a total of up to 15 vehicles, also including the 200E and 230E, will be fitted with ceramified cylinder heads and road-tested in the medium-term.

Daimler-Benz AG has 10 test vehicles of different types in use. They have now covered more than 1 million test kilometers, and the results are very creditable. Fuel consumption dropped by 8 to 10 percent, depending on driving cycles. Lower friction losses and reduced engine weight make for better performance and higher speeds, and will also mean that smaller engines with the same performance can be built in the future.

It is also of great importance that the modified engines run significantly more quietly. As the internal friction moment is 5 to 30 percent lower than with engines with standard valves, noise pollution is reduced by a perceptible 18 dB at an average speed of 3,000 rpm.

Various problems will have to be ironed out before the valves are ready for series production. Work is required on the part of both the ceramic producers and the automobile manufacturers, as the engine cylinder heads will have to be redesigned, at least to some extent, to render them ceramic-compatible if all the advantages of ceramic valves are to be fully exploited. Another prerequisite for series production is a relatively simple and reliable testing method that detects microflaws in the ceramic structure before final machining of the valves and makes preliminary testing in the engine superfluous.

Germany: Automakers Use Electronics, Light Metals To Economize

Technological Advances

92WS0772A Duesseldorf WIRTSCHAFTSWOCHE in German 7 Aug 92 pp 50-56

[Article by Burkhard Boendel: "A Step Ahead: Auto Engineering: Electronics Advances To Become a Key Technology''; first paragraph is WIRTSCHAFTSWOCHE introduction]

[Text] Sensors, information systems, and new materials improve the economy of the coming generations of autos.

The Trabi was a car of the future—at least in principle. It united two visionary elements of automotive technology: the fully plastic body and the two-stroke engine.

Plastic and two-stroke engines are more timely than ever. Chemistry was the godfather of the fender of the successful French minicar, the Renault Clio. Ford and Toyota are working intensively to tame the two-stroke engine. Ford spokesman Toni Mandla speaks enthusiastically about these lightweight drives currently being tested in various vehicles of the Fiesta type: "As soon as we master the preparation of the mix, we will achieve favorable fuel consumption values compared to the four-stroke engine and without any competition."

The reason for replacing steel with plastic and testing alternative drives remains the same: to economize, to economize, and to economize again, and to do so in weight, fuel consumption, and harmful emissions. According to Mercedes chairman Juergen Hubbert: "Reducing ecological damage has top priority."

This demands titanic developmental efforts from the auto industry, at extreme costs, particularly since automakers have dedicated themselves to a creed: "Cutbacks in performance, safety, and comfort are absolutely taboo," insists Audi spokesman Juergen Zimmermann. After the electric window there is no going back to the crank, and today's proud acceleration values must not be touched. "Consequently, real improvements can only be obtained at tremendous expense," laments Porsche developer Paul Hensler.

The only way out: Suppliers are involved early in development (simultaneous engineering), and fundamentally new technologies are in some cases conceived, built, and tested across trademarks.

Thus BMW, VW, Porsche, Mercedes-Benz, and Bosch are currently cooperating on the diagnostic system, "On Board Diagnosis II." The impetus for it was supplied by the California Air Research Board (CARB), a California environmental authority, which prescribes self-diagnosis of all exhaust-related sensors and adjustment elements beginning in 1997.

The CARB catalog includes 15 criteria from monitoring catalytic converter efficiency to detection of misfiring to checking the lambda probe. Failures or errors are stored in a memory. Data indicating defects to the mechanic can be read out in the garage. Development of the diagnostic system is likely to cost half a billion German marks. "That kind of cost can no longer be financed by a single company," according to Porsche's Hensler.

Experts and environmentalists are already envisioning other applications for the electronic brain of the car. It would be possible to use technical defects in exhaust treatment which are recorded, of course, for subsequent

taxation or fining of polluters. Likewise, the exact fleet fuel consumption of a company could be measured and thus appropriately taxed. The fantasies about gap-free Orwellian monitoring are virtually boundless.

August Miehle, BMW's manager of measurement and electronics development, goes right to the heart of the matter: "Electronics has become the key technology of all automotive engineering." Up to 20 percent of the production costs of a top-of-the-line model are already dedicated to electronic and electrical components—a trend which is still growing. The multi-cable wiring harnesses in the body are being replaced by networks like Bosch's Controller Area Network (CAN) or VW's A-bus. All electrical loads are connected to the data cable, through which data and commands are digitally transmitted.

Bus technology enables connection of virtually any number of intelligent aggregates which will make their way into cars in the future. A few have already been implemented:

- The Citroen XM shows off with an active chassis whose suspension is adjusted to road conditions and the respective driving situation in milliseconds.
- The BMW 850 has a steerable rear axle which turns a few degrees depending on speed. It stabilizes the vehicle in the event of sudden steering movements.
- Some Mercedes S class engines are equipped with selective ignition. The optimum ignition timing is calculated separately for each cylinder.

With the Tiptronic, Porsche developers conceived a completely new intelligent automatic transmission, used in the 968 model just introduced. It is currently the only automobile transmission which permits a free selection between automatic and manual operation—which has itself been simplified. All it takes to shift up or down is to move the shift lever. The clutch is electronically activated.

The electronically adjustable camshaft (VarioCam) of the 968, which controls valve timing on the basis of speed, further increases the performance of the four-cylinder engine. It reduces gasoline consumption despite high speed. BMW press spokesman Alfred Broede, responsible for the eight-cylinder engines of the fifth series, is also announcing "variable camshaft control" (Vanos) for the next model. After test runs, the developers in Munich promise: 7 percent less fuel consumption.

The developers of internal combustion engines will still have to pull a few more such tricks out of the hat if they intend to keep pace with the diesel engines which are already much more economical. The Audi TDI, equipped with a direct injection diesel engine, consumes only six liters of fuel in 100 kilometers in a one-third mix. With an output of 88 kilowatts (120 HP), it brings this mid-range car to a top speed of 200 kilometers per hour. Such data are even persuading buyers. Every 10th Audi purchased is already a TDI.

Since April of this year, the engines have also been equipped with exhaust gas recirculation and oxidation catalyzers. While the recirculation of part of the exhaust into the intake air lowers the combustion temperature in the cylinder and thus produces less nitrogen oxide, the catalyzer converts unburned hydrocarbons (HCs) and carbon monoxide (CO) into less harmful chemical compounds. The TDI engines thus meet the strong emission standard of 0.08 grams soot per kilometer.

Two years after introduction of this diesel engine, Audi still stands alone with the futuristic, electronically enhanced design; according to the high priest of the automobile, Prof. Franz F. Pischinger, of the Aachen Technical University: "The future belongs to the direct injector."

However, Ferdinand Piech, currently head of the VW group in Wolfsburg, refuses to change his mind. At the beginning of 1992, he announced a car for the turn of the century which will get by with 3 liters of gasoline per 100 km. To meet this ambitious goal, the skills of engine builders no longer suffice. Weight must also be drastically reduced, rolling resistance decreased, and the body must become even more aerodynamic.

In addition to some fiber-reinforced plastics and aluminum, magnesium, with which primarily the Japanese automakers are experimenting, has recently come into increased consideration as a lightweight construction material. "They are a step ahead of us in this," acknowledges Wolfgang Henning, materials technology team leader for Kolbenschmidt AG in Neckarsulm.

Even here in this country, the lightest structural metal, which weighs one-third less than aluminum, has been rediscovered after being banished from the automobile at the beginning of the 1970s because of stability and corrosion problems as well as high prices. In the meantime raw material manufacturers such as Dow Chemical have created new alloys which meet the demands of the automakers. Mercedes is already using the metal in seat frames. Audi is using it for instrument panels.

Kolbenschmidt—the largest German supplier in auto construction after Stuttgart's Mahle GmbH—is working on a magnesium piston reinforced with ceramic fibers. Henning anticipates that this component will be "at least 25 percent lighter" than a conventional product. The reduction in gasoline consumption should be considerable since the drop in weight of very rapidly moving engine parts results in particularly high savings. However, the magnesium piston will be ready for series production in five years at the earliest.

But it remains to be seen whether technical measures can bring the required drop in emissions—according to which carbon dioxide pollution from road traffic is supposed to fall by 25 percent by the year 2005. In any case, Andreas Troge, vice president of the Berlin Federal Office of the Environment, does not think so: "Our forecasts clearly show that we cannot escape measures to regulate traffic."

Volkswagen's Seiffert on Future

92WS0772B Duesseldorf WIRTSCHAFTSWOCHE in German 7 Aug 92 pp 56-58

[Interview with Ulrich W. Seiffert, Volkswagen research chairman, by Herbert Fuchs and Stefan Schlote; time and place not specified: "'Wearing Shorts': VW Chairman Seiffert on the Future of the Automobile"; first two paragraphs are WIRTSCHAFTSWOCHE introduction]

[Text] Mobility will be saved with a complex information network and low-emission vehicles.

Ulrich W. Seiffert, research chairman of Volkswagen AG since 1988, has been on the fast track. A mechanical engineer by training, he started in the Vehicle Safety Department in 1966. In addition to his professional activities, he received a doctorate from the Technical University in Berlin in 1974 and has been an honorary professor at the University of Braunschweig since 1986.

WIRTSCHAFTSWOCHE: Mr. Seiffert, the automobile has fallen into disrepute. It fouls the environment and, because of continuous traffic jams, it has become unattractive as a means of transportation. Can the auto be saved?

Seiffert: It is not even in danger. We thrive on mobility, and mobility is a basic factor in our economy. To preserve it we must use intelligent systems and make cars more environmentally compatible. The opportunities for this have never been better. With Mr. Krause, we finally have a Minister for Transport who, as a computer scientist, thinks in terms of linkages.

WIRTSCHAFTSWOCHE: What intelligent systems are you thinking about?

Seiffert: We need a total information network on the streets using induction loops and data transmitters in urban areas. Navigation systems and radios which can receive traffic data must be built into cars. Only then can road capacity be utilized optimally.

WIRTSCHAFTSWOCHE: And who is supposed to pay for this gigantic investment?

Seiffert: The state must act as the catalyst. Reserves are provided for these purposes in the road financing plan. The information network could be built with them. Each individual would have to pay for the installations in the cars.

WIRTSCHAFTSWOCHE: You will not get much enthusiasm for that from drivers.

Seiffert: It is not so drastic as all that. If these devices were mass-produced, they will hardly cost more than a medium-priced car radio. However, the will to build such an information network must first exist. The greatest handicap today is the fact that no politician dares to publicly declare: "We want mobility." They prefer to be photographed in shorts on bicycles....

WIRTSCHAFTSWOCHE: But you still have not solved the second problem, the high emissions from traffic.

Seiffert: We have undertaken to reduce fleet consumption by 2 percent every year. And if we do not run into another anti-diesel movement, we will do just that.

WIRTSCHAFTSWOCHE: Tell us in concrete terms how you intend to meet your annual goal in 1993.

Seiffert: Beginning in the spring of next year, we will market a Golf powered by a 1.9-liter environmental diesel with four-speed automatic. In mixed travel you save 22 percent fuel with it. We expect consumption of 5 liters per 100 km.

WIRTSCHAFTSWOCHE: And someday the electric Golf is coming....

Seiffert: Not someday, next year.

WIRTSCHAFTSWOCHE: How do you intend to find buyers with a price tag of 70,000 German marks [DM]?

Seiffert: Whether our electric Golf will be so expensive has not yet been decided. That depends on the cost of the battery. If nothing critical happens, we already have our hybrid design.

WIRTSCHAFTSWOCHE: Whether such vehicles, with which it is possible to selectively drive with diesel or with an electric motor, will go into series production is however still open.

Seiffert: A large-scale test with hybrid Golfs is currently underway in Zurich. If it is completed successfully, we will have come a long way. The hybrid drive also solves the problem of long trips, which is virtually insurmountable with a pure electric drive. Your tank is filled with diesel for your vacation trip; otherwise, you drive short runs, predominately in city traffic, with the emission-free electric drive.

WIRTSCHAFTSWOCHE: And how are things coming with the Swatch car?

Seiffert: It is coming along fine, with Mr. Hajek. We have always said that we will decide in October whether we can implement the technical innovation which we both envisage. I am an absolute optimist as far as problem-solving goes. We have enough pessimists. We even have professional pessimists.

WIRTSCHAFTSWOCHE: Most technical people are in fact optimists....

Seiffert: ...fortunately. If you do not believe in a project, it fails.

French Government Signs Electric Car Framework Agreement

92WS0778D Paris AFP SCIENCES in French 30 Jul 92 pp 33, 34

[Text] Paris—The government decided 28 July to give a "boost" to the promotion of electric cars by cosigning a "framework agreement" with Electricity of France (EDF) and automakers. The agreement aims to set up the embryonic infrastructure that will be needed to distribute electric vehicles to the general public beginning in 1995.

The accord was cosigned by the ministers of environment and industry, Segolene Royal and Dominique Strauss-Kahn, and by Louis Schweitzer, the president of Renault Co., Jacques Calvet, the president of PSA Peugeot-Citroen group, Gilles Menage, EDF's president, and Jean-Louis Richard, the president of the Electric Vehicle Interministry Group (GIVE).

Initially, the agreement will concern 10 French cities where electric terminals for recharging the vehicles will be installed. The final list of urban centers is expected to be drawn up this fall. It is already known, however, that it will include Tours and La Rochelle, with whom PSA Peugeot-Citroen group has already signed accords, and Chatellerault, which signed with Renault.

Mrs. Royal mentioned the cities of Cannes, Dijon, Douai, Dunkerque, Grenoble (whose university has signed an agreement with Renault), Lyon, Marseille, Metz, Montpellier, Nantes, Paris, Rouen, Strasbourg, Saint-Germain-en-Laye, Toulouse, Valbonnne, and Sophia-Antipolis, as well as new towns such as Evry. But the minister cautioned that the final selection would be based on "objective criteria" such as "the financial willingness to combat noise and acquire systems for measuring air quality, and the candidates' demonstrated effort to draft a public-transport policy or acquire a substantial fleet of electric vehicles."

At the same time, the framework agreement stipulates that its signatories will develop a standard system for charging electrical batteries. In collaboration with the industries concerned, they will design and set up a system for distributing batteries, make sure that maintenance departments for electric cars are created, and launch information and training programs on the new techniques.

The state will ante up a total of 500 million French francs [Fr] over a two-year period, as part of the Research and Development Program for Highway-Transport Innovation and Technology. Automakers are being asked to deliver "mass-manufactured" electric vehicles—that is, several thousand at a time—starting in 1995.

There are now 19 different electric-vehicle prototypes in Europe, and all the automakers have at least one, or in the case of Renault or PSA Peugeot-Citroen, even several to their credit. But the marketing of electric cars (except for sales to fleets such as EDF's or municipalities') has so far been hindered by their prohibitive cost—which is nearly double that of an equivalent thermal-engine car—and their limited autonomy. None of the electric vehicles can travel over 100 kilometers under normal operating conditions without recharging their batteries.

Mrs. Royal pointed out, however, that one car trip in two involves no more than 3 km, and that the distance traveled in one trip out of four is less than 1 km. She also stressed that, although 500,000 households buy a second car each year, the latter is never used to travel long distances or on vacation trips, but for daily needs averaging 40 km a week. All these facts argue in favor of using electric cars, which are quiet and non-polluting.

Automakers and battery manufacturers have often repeated that they will not be able to reduce their costs until they can achieve a substantial sales volume, in the neighborhood of several tens of thousands of vehicles a year.

BMW Builds Prototype for Hydrogen-Fueled Car

92WS0805B Stockholm NY TEKNIK in Swedish 20 Aug 92 pp 10-11

[Article by Miki Agerberg: "Car With Hydrogen Gas in the Tank"—first two paragraphs are NY TEKNIK introduction]

[Text] Hydrogen gas-powered cars are no longer a Utopian vision that only a few dreamers believe in. Many big companies now expect environmentally-compatible hydrogen gas to be one of our most important fuels in the future.

"Technically hydrogen gas is a reasonable alternative to gasoline and diesel fuel," said Wolfgang Strobl of BMW, one of the car manufacturers putting the most effort into hydrogen gas operation.

As early as 10 years ago BMW, the prestigious German car manufacturer, began preparing for a life after the gasoline age. The company began an extensive development effort focused on two parallel ways to make car travel more environmentally compatible: the electric car and the hydrogen gas car.

Since then BMW has built a number of prototypes of both kinds of engine and opened the world's first test facility for hydrogen gas engines.

The latest hydrogen gas model is a big car, a rebuilt BMW 735. In the trunk is a tank that holds 120 liters of liquid hydrogen but the engine is a slightly modified six-cylinder standard 3.5-liter engine.

This car has a driving range of around 30 Swedish miles before it needs refueling and its power is only 30 percent lower than that obtained from the same engine when it is fueled with gasoline.

So far no electric car has matched this achievement.

Suitable for Highways

"Even in the long run electric cars will probably be most suitable in city traffic where driving distances are short," said Strobl. "Hydrogen gas is more suitable for multipurpose cars that are used in driving long distances."

BMW is not alone in this assessment. At the Hydrogen '92 world conference, held in Paris during the summer, there were many who thought the hydrogen car has been unjustly overshadowed by the electric car in recent years.

Strict new environmental requirements make it necessary to find alternatives to gasoline and diesel fuel. Hydrogen gas is at least as good a solution as electric power, according to those who work with it.

Not an Energy Source

Like electricity hydrogen gas is not a source of energy but an energy bearer that can be produced from any energy source. And like the electric car the hydrogen car does not give off any harmful emissions at all during operation (aside from a small emission of nitric oxides if the hydrogen gas is used in a combustion engine like the BMW engine). Otherwise all that comes out of the exhaust pipe is water vapor.

If hydrogen gas or electricity is produced from fossil fuel or nuclear power little more is accomplished than shifting the problem. But BMW and the others who work with hydrogen cars are aiming at eventually producing hydrogen gas from renewable energy sources.

Accordingly BMW is a copartner in the futuristic Bavarian solar hydrogen project in Neurnburg, a unique pilot plant for the production and distribution of hydrogen gas from solar energy (see NY TEKNIK 1989:48).

Dual Equipment

When BMW sells its first hydrogen cars they will at first come with dual equipment so they can run on both hydrogen gas and gasoline; this is because it will take a long time before a functioning distribution apparatus for hydrogen gas is built up.

"For the next couple of decades it will be a question of producing limited quantities for customers who have plenty of money and want to do something for the environment," Strobl said.

This does not worry him:

"All new technology begins with small production series. Think of nonlocking brakes; it took 30 years before they succeeded on a large scale."

Japanese Too

But it is not just the Europeans who are interested in hydrogen gas operation. Mazda displayed the HR-X, a beautifully designed prototype for a hydrogen-powered passenger car in car showrooms in Tokyo this fall.

Mazda uses a rotary engine instead of an ordinary Otto engine:

"It gives better combustion and lower nitrogen emission," said Eiji Takano of Mazda's research division.

This engine is assisted in accelerating by an electric engine that is powered by a nickel hydrogen battery. The hydrogen is not stored in liquid form but bound in a metal hydride. This is thought to reduce the risk in an accident but at the same time it makes the tank heavier and shortens the car's driving range.

Fuel Cells

Today there is growing international interest in an entirely different way to use hydrogen gas as a fuel: instead of using it to fire a combustion engine hydrogen gas can be used in fuel cells to produce electricity. The car is then propelled by an electric engine; it is very quiet and there are no nitrogen emissions at all.

Researchers at the American Academy of Science have developed a fuel cell using the membrane technique and have installed it in a passenger car that they named LaserCel 1. It meets all the requirements for a zero-emission car and at the same time the range is considerably greater than it is for GM's well-known electric car, for example.

Thus there are several different lines of development for hydrogen gas vehicles, concerning how to store the hydrogen gas as well as how to use it.

A lot of development work remains to be done, of course, especially with regard to safety (liquid hydrogen has a temperature of - 253°C and must be surrounded by heavy insulation).

But those who work with the question see no important technical obstacles to the hydrogen car.

"The biggest obstacle is economic," said Reinhold Wurster. He is a hydrogen gas expert at the Bavarian firm of Ludwig Bolkow.

Today hydrogen gas is considerably more expensive than gasoline and diesel fuel. Refueling with liquid hydrogen is also a complicated procedure which currently takes an hour including a cooldown and a warmup. Several companies are working on developing a fully automatic system that will cut the refueling time to 10 minutes.

Must Be Simpler

"Using hydrogen gas must be simple," said Wurster. "As much like gasoline and diesel fuel as possible."

Wurster thinks the introduction of hydrogen gas operation will begin with buses and municipal service vehicles. There they have experienced professional drivers and frequent technical checks.

"Eventually, as the distribution system is built up, hydrogen cars could make a big breakthrough with the general public. That will be 20 to 30 years from now."

BIOTECHNOLOGY

French Researchers Map 25 Percent of Human Genome

92BR0694 Paris SCIENCES ET AVENIR in French Aug 92 pp 12-13

[Text] The Research Center for Human Polymorphism (CEPH) and the Genethon [center] have taken the lead in the race to physically map the human genome. The team, directed by Daniel Cohen, has already mapped 25 percent of the genome, including virtually all of chromosome 21. This achievement is the fruit of a new mapping technique that is five times more powerful than the conventional mega-YAC [yeast artificial chromosome] technique. To draw a physical map of the genome, the researchers cut the human DNA into small segments which they insert into the yeast nucleus in the form of artificial chromosomes. These are YACs. These artificial chromosomes are reproduced by the yeasts and then positioned so as to form a "map" whose overlapping parts constitute the reference points [nucleotides] along the DNA chain. Until now, conventional YACs contained only about 200,000 pairs of nucleotides. The French perfected the technique by producing mega-YACs containing sequences of almost 1 million pairs of nucleotides, which are the building blocks of DNA. This is an extremely slow and delicate undertaking which has discouraged research teams around the world. In reward for their efforts, Cohen predicts that 90 percent of the genome will be mapped by the end of the year [as published]. Mapping the remaining 10 percent will be a more delicate task, because it will entail "plugging the gaps" scattered along the genome.

Market, Legal Problems for German Biotechnology

92WS0702B Frankfurt/Main FRNKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German, 13 July 92 p 1

[Text] While genetic engineering has for a long time been taken for granted in the United States and Japan; in the German Federal Republic the industrial utilization of the results of research in this field has developed sluggishly. Many businesses hesitate to make investment plans because they fear protests from politicians and from the general public. In addition to this, licensing procedures for new biotechnological facilities at German sites are very slow. The genetic technology law of 1 July 1990 is one of the strictest safety precautionary measures in the world. These factors combined reduce the prosepcts of German businesses in this international growth market, according to the Institute of German Business in Cologne in the most recent issue of its information service.

According to a study of the European Chemistry Association the market for the new products of biotechnology in the next 10 years will increase annually, moving from its present volume of DM10.2 billion to a volume of DM167 billion. Among the products and in addition to new drugs for previously incurable (hereditary) diseases, will be biotechnological pesticides and new strains of useful agricultural plants. Faced with these prospects, in the EC alone by the year 2000 about 2 million jobs will be created, which will be directly related to biotechnology, the Cologne institute writes.

According to the institute, the expected upswing has led to intensive research efforts in all industrialized countries. Germany, which is spending about DM480 million annually for biotechnological research, is by no means in first place as compared to other European countries, the institute further reports. Great Britain alone invests about DM1 billion annually in biotechnological research, and in 1991 the U.S. invested approximately DM5.7 billion.

The relatively small amount of funds in Germany would obviously be well spent, according to the report. As measured by the number of patents, Germany occupies third place in biotechnological research after the U.S. and Japan.

Germany: Max Planck Society Reports on Working of Law on Genetic Engineering

92MI0720 Bonn TECHNOLOGIE-NACHRICHTEN MANAGEMENT-INFORMATIONEN in German 15 Aug 92 p 6

[Text] The general conditions now prevailing give grounds to fear that scientific and industrial genetic engineering research will suffer an irreversible setback, if it has not already done so. Industrial research is stagnating in Germany, with promising projects now carried out almost entirely abroad. Basic research is also in decline, and becoming less competitive. Such are the conclusions reached by the Max Planck Society (MPG) in its statement, just submitted to the Bundestag and the federal and land ministers concerned, on its experience of the law on genetic engineering and its administrative implementations: The statement is based on responses to a questionnaire circulated by the MPG in March 1992 to all relevant Max Planck institutes.

The statement goes on to point out the increasing difficulty in finding qualified research personnel—a trend likely to continue. The training of young scientists is stagnating, and the necessary interchange between science and industry is declining, even for the contract research projects vital to basic research.

The Max Planck Society has drawn up a list of requirements for improving the genetic engineering research situation. These include:

- Abolition of registration procedures for genetic engineering facilities or work at safety level 1 (no risk potential to mankind or the environment): this safety level covers 80 percent of all genetic engineering projects;

- Simplifying the licensing procedure for genetic engineering facilities, especially at safety level 2 (slight risk);
- Simplifying registration and licensing procedures for other genetic engineering work, at safety levels 2 to 4 (slight, medium, and high risk), so as to do away with superfluous, unwieldly administration work;
- Simplifying the licensing procedure for releasing genetically manipulated organisms;
- Simplifying the recording of genetic engineering work at all safety levels;
- Facilitating national and international exchange and transport of genetically manipulated organisms;
- Totally exempting nonuniversity research establishments from registration and licensing charges for genetic engineering facilities (similar to the exemption for universities);
- Shortening the registration and licensing procedures;
- Listing by the Central Commission on Biological Safety of vectors and vector/receiver systems, and of genetically manipulated organisms eligible for release, so as to simplify registration and licensing procedures;
- Abolition of unnecessary official regulations and measures (such as showering at level-1 genetic engineering facilities);
- Simplifying safety courses for project leaders;
- Clarifying individual terms and definitions used in the law on genetic engineering; and
- Science-friendly formulation and application of EC legal requirements.

The Max Planck Society is not seeking to bypass safety and environmental requirements that are of genuine relevance; it is, however, seeking the removal of regulations that not only do nothing to enhance safety, but also impede research to an unreasonable extent. The MPG sees it as a matter of urgency to achieve substantial improvements in the general conditions for scientific and industrial genetic engineering research. Only then will it become possible to retain—or indeed to acquire or regain—a central position for Germany in genetic engineering.

Germany: Mammalian Retina, Computer Technology Used to Analyze Human Brain's Visual Image Perception

92WS0750A Duesseldorf VDI NACHRICHTEN MAGAZIN in German Jul 92 pp 8-13

[Article by Anne-Lydia Edingshaus: "The Cosmos Within the Head"]

[Text] In the middle of Paris, on a low hill, stands the Museum of Man. Here the forebears of humanity are studied. In an out-of-the-way section of the museum there are dusty cabinets, then a long table, covered with neatly inscribed human skulls. On the walls are shelves with tall glass cylinders. In them gray furrowed masses can be seen, swimming in formalin: human brains. One bears the label: Paul Broca. Here is archived the brain of the man whose discoveries first made modern brain surgery possible. There it is, preserved like the other brains of his laboratory collection, with which he used to experiment.

Broca made a name for himself because he discovered a tiny region in the left temporal lobe: the speech center, called the "Broca center" in his honor. The surgeon, who died in 1880, had discovered that a specific site in the brain is allocated to specific brain functions, that there is a link between anatomy and brain activity.

Now, thanks to remarkable advances in brain research during the past half century, we are beginning—albeit gradually—to understand a little better how the brain, one of the most fascinating and still one of science's greatest mysteries, accomplishes all those things which no other organ, which no other technology is capable of accomplishing.

In fact, if there were a technique for measuring human capabilities, it would point to its own limitations. It is precisely the success in computer technology, in information theory, and cybernetics that have revealed the superiority with which the "machinery" of the human brain actually functions: It can analyze data, compare it with prior experiences, and select and monitor appropriate processing chains. However, scientists will continue for a long time to rack their brains about what processes are performed individually in what way. The brain is a cosmos in itself.

The eye has long been considered the "window of the soul." That is how Hildegard von Bingen described the organ of vision in the Middle Ages, "with its seat located higher than the other senses," and with which man perceives and understands the world. The eye—a key to the door to awareness? Even today, although on a different scientific plane, the question of how the eye interprets visual scenes occupies a few researchers who are trying to trace the interwoven paths of the innumerable nerves. How are images of physical reality, based on which we ultimately orient ourselves and behave, created in our heads? How do sensory stimuli become perception? What learning processes play a role in this? What principles lie behind the self-organization of the brain? How does the memory work?

Despite all these efforts, no one can explain what happens in the brain in which approximately 100 billion nerve cells are linked to each other via conductors of a total length of a million kilometers. The cerebral cortex is precisely structured in layers, capabilities such as sight, hearing, and speech reside in specific areas, and all connections in the brain are purposeful. Order prevails inside our skull. However, precisely because of this, researchers can restrict themselves to a limited area to explore the specific functions localized there.

"If we want to understand the brain, we must imitate it." That is how it seems to Christoph von der Malsburg, physicist and brain researcher at the Ruhr University at Bochum, who has become internationally renowned for his theories of the self-organization in the embryonic brain. "Thus it is stimulating to investigate individual problems to understand them, for example, through technical imitation." Von der Malsburg is concerned above all with the performance of the eyes: "In past years, tremendous manpower has been developed whose goal it is to tackle the problem of the brain." The researcher breathes in audibly: "We are, so to speak, in a prerevolutionary phase: The artillery is in place; however, the revolution has not yet occurred."

According to many scientists in artificial intelligence, vision assumes many forms: The possibility of building intelligent machines, computers which can take over and perform simple tasks independently, is coming closer. Ultimately, even thinking devices, which as the American physicist and Nobel Prize winner imagines them, will already be capable during the next century of conversing with humans and understanding and interpreting human behavior.

However, machine intelligence is still far from reality. If a modern supercomputer wanted to match its capabilities with those of the brain of a mouse, for example, it would come off badly: To be sure, the computer calculates reliably and rapidly, but as soon as it needs to recognize patterns, orient itself, make associations, interpret things, it fails miserably. And to all skeptics who see the aura of the human spirit threatened by thinking machines, researchers respond: There is no reason to assume that intelligent machines created by humans can ever have feelings such as love, curiosity, repulsion, or pain. "What we want to find out about the brain is the fundamental principle by which knowledge is recorded and regenerated and by which new forms emerge," explains Von der Malsburg. "However, what takes place in an individual brain, will always remain out of the reach of science."

Various groups of cells are active in the generation of ideas. For the brain to function, individual neurons must be connected into groups and these groups must be connected to each other according to specific patterns; that is the only way that relationships in reality can also appear related in the brain. The connections are made over fibers with many branches which emanate from the nerve cells. At their ends transmission handled by switch points, the so-called synapses: Through the synapses, the neurons can mutually stimulate or inhibit each other, i.e., trigger or block signals.

"My work," according to the neuro-computer scientist, "led to a critical point: The cells have to know which other cells they are grouped with. This coordination occurs because they synchronize their signals and fire simultaneously." In other words: The neurons discharge themselves at the same rhythm, 40 to 60 times per second. This discovery solved a great problem: How else can many different sensory stimuli be processed immediately in the brain without the varied data being linked at a "higher point" into a meaningful whole? This is only possible because signals are active in synchronization, the neurons thus combine the elements perceived into one image in a conference call.

The retina offers an ideal research object for these processes; because the retina of the eye is a clearly structured system of nerve cells and part of the central nervous system in terms of developmental biology. Consequently, it can serve effectively as a simple model for functional cycles in the brain. Its inhibiting and stimulating connections, like the morphological differentiation of nerve cells, as well as the variety of transmitters and the modulation of synaptic transmissions can be studied on the retina, by way of example.

During the growth and maturity process, it sends out fibers which find their way to the diencephalon. There they are connected to nerve cells which then forward the signals to the cerebral cortex. At first, these connections are still somewhat chaotic, but they slowly order themselves until finally neighboring sites in the eye are cabled to neighboring sites in the brain. It was possible to observe how this occurs in the brains of animals. But how do the fibers know where they must grow to?

Scientists sought the answer for decades in innumerable experiments. They postulated theories and disproved them until only one remained: There are two mechanisms which serve for positioning and sorting. The positioning mechanism is organized with chemical labelling materials and these provide the fibers growing into the brain the capability, so to speak, of sniffing the surroundings for the scent of their stable which they brought with them from the retina and now recognize again. The sorting mechanism permits the fibers to seek out, sense, and find their target area based on their former neighbors in the retina.

According to Christoph von der Malsburg: "The sorting mechanism functions thus: The fibers are already spontaneously active in the embryo, and the activities of the neighboring fibers are correlated with each other. They fire in rhythm. The fibers then need only seek out their home rhythm in the target area and then attach themselves."

"Firing in rhythm"—this means the time structure of the nerve signals which plays a role not only during embryonic development. In the adult brain, this time structure is important for the coordination of relationships. It is not enough to know which cells are active at a specific time; instead, it is a question of how the different elements break down according to individual objects. If, for example, two humans are standing face to face and one of them is wearing a hat and is laughing; then the other knows immediately that the hat and the laugh belong to the same person. In order for the brains to perceive such elements as belonging together, a sort of

"glue" is necessary which can connect the element and the symbol and produce relationships.

At the Max-Planck-Institute for Brain Research at Frankfurt, it was possible to actually find time structure and synchronicity in experiments with alert animals. Institute Director Professor Wolf Singer tersely admits: "It was purely accidental." He smiles: "We were investigating the vision system of mammals since we were fascinated about how the world is perceived. As fate would have it, we discovered the synchronous time structure in the process." Singer explains more precisely: "Nerve cells in the vision system of animals actually have in their responses a distinct, high-resolution, time pattern, and under specific conditions physically distributed nerve cells are capable of synchronizing their respective responses. And they seem to do just that when they deal mutually with the encoding of contours which belong to the same object."

The brain researcher remembers how this discovery came about: When a technical problem developed in the conductive apparatus, Singer and his colleagues produced measurement conditions which made brain signals visible and audible. "We had permanently implanted electrodes in the cerebral cortex of cats. They were supposed to record the activity of nerve groups in alert animals. However, it was impossible to determine without difficulty whether the signals actually originated in the activity of the nerve cells. Furthermore, a few electrodes showed no activity. Because I wanted to find out whether they were poorly connected or even completely mispositioned in the cerebral cortex, I changed the filter so that I would have to be able to see at least one electroencephalogram, an EEG." Enthusiasm creeps into Singer's voice: "All at once, the periodic, high-frequency EEG signals which we call field potentials appeared. Because I was not sure whether this phenomenon really had to do with the synchronous time structure, it was a few months before I mentioned the discovery to my colleague Von der Malsburg, with whom I have been friends since school days. Not until I ran into him at a convention did I tell him, under the cloak of secrecy, what we had discovered. I did not want to create a stir and then possibly have it prove to be nothing."

At that time, the two friends discussed the fact that Singer's discovery could perhaps be the experimental confirmation of Von der Malsburg's theories. A few years passed, the scientists continued their research and exchanged their findings. Singer explains: "We still do not know if we have actually put our finger on the encoding algorithm. It is possible, but we still cannot prove it. We still have much to do to find out."

Von der Malsburg sees great success in the work of the researchers in Frankfurt: "It will probably start a revolution in neurophysiology." The area of artificial intelligence is currently being rethought. Until not too long ago, the conviction still prevailed that the art of constructing intelligent systems consisted of nothing more than writing the right software and letting it run on the computer. Thus, the computer plays chess or gives information on a technical or medical subject in an expert system. However, the writing of programs was never able to keep up with the requirements. So, AI [artificial intelligence] experts are currently thinking about breaking with the old organizational principles based on prewritten programs and converting their projects to self-organization. Von der Malsburg believes that self-organization is the model of nature, with which intelligence can be understood. In complex systems, chaotic processes occur, which order themselves into structures after a certain time. Such processes allowed the stars and the galaxies to form and finally all evolution to occur. Cloud formations and the movement of ocean currents also belong to this type of self-organization.

Every brain also interlocks and programs itself—first with the instruction delivered by the genetic material, then through experience, which makes its impression during the maturation process and with which it refines its structure. Von der Malsburg explains: "Self-organization is the only explanation for the emergence of thoughts, for the ordered structures in the brain. That means it begins with an originally chaotic system, which is dominated by simple rules, and these cause the system to fall into regular states."

Now computer scientists and AI experts are ready to talk with brain researchers and mathematicians about the process of self-organization. At the Institute for Neural Computing and the Chair for Theoretical Biology of the Ruhr University at Bochum, scientists had arrived at a point where they could move no further with conventional methods. So they were attempting to imitate model neural structures with specific electronic systems. Their goal: Artificial hand movements, artificial hearing and vision.

Von der Malsburg and his team want to give the computer vision, want to find out in the process what is involved in the identification of objects or even in the interpretation of entire scenes. "We are photographing faces using a camera," reports Von der Malsburg, "and now a complete gallery of faces. Whenever someone comes to see us, he is introduced to the system, and the system must then be able to recognize him in the future by itself."

The lab is reminiscent of a high-tech video studio. Transputer systems stand in a row one on top of the other. Tiny red lights flash, followed by whirring and clicking. Signals are digitized by video cameras and calculated by the transputers. One of the researchers sits in front of the camera, pulls his hair into his face, grimaces—his face is hardly recognizable. After a few minutes, the gallery of pictures is expanded by an additional portrait. The devices begin to work. Lines appear on the screen, become points, from which contours rapidly form. Suddenly, two faces appear next to each other: The computer recognized the test person despite his distortion.

While the scientists at Max-Planck-Institute at Frankfurt are trying to unlock the architecture of the brain, the researchers at Bochum are concentrating on usefully reproducing the structures found by their colleagues on the computer. Thus they have developed this object recognition system which can identify faces, even if they look different because of beards, glasses, grimaces, or new hairdos. It can even recognize other objects, regardless of their physical attitude or the lighting: a development which will play a significant role in industrial automation in the future.

Von der Malsburg raves: "This system stores models of faces and applies them to the actual image using contortions, shifts, enlargements, reductions, or rotation. The correspondence between the stored model and the new image must be developed such that subregions here correspond to subregions there. This type of adaptation seems to me to be indicative of the action of the brain which consists of mere models which are only waiting for the opportunity to enter into actual scenes."

The goals of the Bochum researchers are ambitious: "It is our dream to coordinate the eye and hand in machines. Our eye naturally consists of two cameras, which can thus estimate stereoscopic distances." That is precisely what machines should be able to do someday: Cameras, for example, which control the movement of a robot hand so that it picks up the sugar tongs on the table set for coffee. According to Von der Malsburg, "When we do that, we will have understood the essential mechanism of the brain."

Photo caption

At the Institute for Neural Computing at the Ruhr University at Bochum, video cameras and the computer emulate vision. This man remains familiar to the computer despite his grimaces: The photographic portrait is resolved into picture points; for each of the points the computer calculates a jet, a combination of 40 numbers, which characterize the surroundings of the points. Then 80 appropriate points are selected and connected into a graph with flexible connections. When the computer compares a new image with the stored images, it can identify the face based on similarity.

German Group Genetically Engineers Potatoes for More Sugar

92WS0785C Frankfurt/Main FRANKFURTER ALLEGEMEINE in German 12 Aug 92 p N1

[Unattributed article: "Sweet Little Potatoes: Reversed Gene Inhibits Starch Synthesis"]

[Text] The long-known sweet potatoes or yams are actually not potatoes at all and are also not really sweet. However, now scientists have grown potatoes that produce sugar instead of tasteless starch. The most prevalent stored product in the potato tuber is usually starch at about 75 percent of dry weight, usable as an energy reservoir for the plant and as food for us. It has now been discovered that potato tubers change their metabolism dramatically upon suppression of the process for synthesizing starch—they produce sugar. No one has yet tasted them and no one knows how sweet the potatoes actual taste. The tubers harvested thus far in the greenhouse of the Institute for Bioengineering Research in Berlin are much too good to eat. They are used exclusively for scientific experiments.

Starch consists of long chains of sugar molecules which are combined with each other during synthesis in the plant cells. In this process, the sugar building block is glucose, which cannot be added to starch in its pure form, as glucose. The molecules must first be activated and charged with energy for the chemical combination. This happens as with virtually all biochemical activation processes through the addition of phosphate groups. This task is performed by an enzyme, "ADP-glucose-pyrophosphorylase." The glucose thus activated seems to only be important for the synthesis of starch and not to play a significant role in any other cellular process.

Bernd Mueller-Roeber and Uwe Sonnewald of Lothar Willmitzer's research team were the first to isolate the gene responsible for this enzyme and reincorporate it into the potato plant in the opposite orientation. In this form, a "reversed" ribonucleic acid is produced by the gene. It attaches to the natural, proper ribonucleic acid and makes it unusable. Thus, the normal enzyme can no longer be produced. With this process, individual plants are always produced in which the gene is not fully suppressed. Extremely varied gradations are found. Thus, even genes essential to life can be investigated. If they were completely suppressed, the cells would have died.

The enzyme which activates the glucose in starch synthesis seems not to be essential to the development of the potato plant. The plants are green and strong even with the enzyme completely suppressed. The changes take place under the ground. Instead of the usual eight to 16 tubers, there are now between 41 and 91. The total weight of the harvest does not increase so sharply. It climbs from approximately 170 grams per plant to 240 grams, since the tubers are smaller. They no longer contain starch, but 10 times as much sugar as normal potatoes. The proportion of almost 40 percent soluble sugar also results in a high water content. The proteins which contribute to the dry mass have changed significantly in their weight relationship to each other.

The starch-free potatoes sprouted and grew as well as seed potatoes which were not genetically altered. In the succeeding generations, it was confirmed that the reprogramming for sugar storage is really inherited, since all newly grown daughter plants presented the same characteristics. All these tests have been performed in the greenhouse. How will these plants behave in agriculture? Will they always contain a high proportion of sugar, or will this characteristic be lost? Could we one day even

cultivate potatoes for sugar production? Such questions can only be answered through field experiments.

COMPUTERS

French Devise Operating System for Parallel, Failure-Tolerant and Real-Time Systems

92WS0629A Munich COMPUTERWOCHE in German 5 Jun 92 p 17

[Text] The cooperation between the UNIX System Laboratories (USL) and the French company of Chorus Systemes S.A., Paris, is yielding its first results. Both the Chorus microkernel itself and the operating system based on it now support UNIX V.4.

At the end of last year USL spent $1 million to buy into Chorus. The French are fulfilling their part of the development agreement with the UNIX manufacturers by releasing updated product versions to them. This made the microkernel specialists into a Value Added Reseller (VAR) of UNIX V.4.

Besides the improvement in performance and handling of virtual memory, Mix 4.0, release 1.2, is particularly notable for the possibility of partitioning the kernel. It is claimed that because of this the product is particularly suitable for use in parallel systems and for failure-tolerant and real-time systems.

Chorus, a French software house, is known worldwide as one of the most important suppliers for failure-tolerant real-time systems based on microkernel architecture. These qualities are used by the telecommunications company Alcatel, for example, for its digital telephone extensions.

Germany Markets External Mass Memory for IBM-Compatible Parallel Interfaces

92WS0629D Munich COMPUTERWOCHE 5 Jun 92 p 25

[Text] External mass memories which are plugged into parallel ports of IBM-compatible computers are being introduced by Comware under the name "Deskfile/P." The Berlin company announces that these products are conceived especially for mobile data acquisition in industry.

According to Comware, all the equipment is in a stable metal housing. They are TUeV tested (VDE 806) and shielded (VDE 871, curve B). The range includes floppy disks with 44 MB and 88 MB capacity and hard disks for 50 to 520 MB of data.

The transfer rate is up to 12 MB per minute. The floppy disks require 20 milliseconds for access, the hard disks operate with speeds of 17 to 12 milliseconds. An 88 MB floppy disk will cost about DM2,800. A 100 MB hard disk is available for about DM2,600.

Germans Develop 486 PC with DIN-A4-Format Housing

92WS0629E Munich COMPUTERWOCHE in German 5 Jun 92 p 29

[Text] The "GT 486/40" computer introduced by Tekelec is available with both DOS and UNIX operating systems. The Munich retailer is drawing attention to a special feature, the small footprint of the 486 PC (40 mH frequency), with a housing designed to be approximately in DIN-A4 format.

The basic equipment includes a 4 MB working memory, expandable to 32 MB, and a 3 ½ inch disc drive. In addition, a hard disc with capacity of 100, 200 or 420 MB can be built in. According to the company, the 15-inch color monitor, the super-VGA graphics card and 1 MB of video RAM should provide good working conditions for graphics applications.

The resolution is 1024 x 768 pixels (non-interlaced). Up to six storage media such as CD-ROM drives or Streamer can be plugged into the external SCSI ports. The price for the desktop computer is about DM5,100 without hard disk or operating system.

French Participation in EUREKA Data Processing Projects Noted

92WS0771B Paris LA LETTRE DE L'INTELLIGENCE ARTIFICIELLE in French Jun/Jul 92 p 7

[Article: "The Eureka Program"]

[Text] The EUREKA program, launched in 1985, is now seven years old: 622 projects have been supported or have received the Eureka stamp of approval; 67.2 billion French francs [Fr] have been committed by the different countries participating in the program. These are the principal quantitative data presented at the Eureka ministerial conference that was held in Finland in May. Pursuant to the annual rotation of the presidency, France (which founded Eureka) is presiding over the program during the current period from May 1992 to June 1993. The method of supporting the Eureka projects is the exact opposite of that of the programs supported by the European Communities Commission [ECC]. The latter selects the projects after bids have been submitted and, until recently, only those topics that could be termed "precompetitive" were considered eligible for submittal of bids. EUREKA, on the other hand, examines any and all applications submitted by the industrial world. The EUREKA method also refrains from a centralized defining of industrial needs and simplifies the bureaucratic public-sector decision-making process. "Launching a program within the EEC ambit requires obtaining the agreement of the Council of Ministers, the various directorates of the ECC, and the European Parliament," says Hubert Curien, the French research minister.

This pragmatic and open aspect of EUREKA's approach is likely to be altered by the new orientations of a planned-economy nature that were decided in Finland:

- Enhanced coordination between EUREKA and the ECC;
- The choice, a priori, of four sectors to be considered strategic for European industry (data processing and language industries sector, automobile sector, factory of the future, and processing of waste);
- Strict conditions to be applied to the admission of the eastern European countries (intellectual property, non-reexportation clauses, financing). As of now, only Hungary has been admitted.

In view of the criticisms being voiced, EUREKA's Secretariat, in an effort to remedy these deviations, is leaning toward the PME [Small and Medium-Sized Business] sector, increased contacts with eastern European countries, and discussions with the ECC. The future will show whether formalism of R&D financing in Europe can be resisted. Seventeen projects involving French participation received the EUREKA stamp of approval during the most recent EUREKA conference. Other projects rallied significant support. LLIA provides a list of these projects relating to information processing:

- Eurolang for development of a machine-assisted translation system. Project manager: SITE;
- IRTC for the development of a platform for the conception and execution of real-time applications incorporating knowledge bases. Project manager: Corelis;
- Alasca for the development of tools to assist in the planning of flexible cells for the assembly of large objects. Project manager: Pianella & Traversa. In France: Apsis/Itmi;
- Maine, a program of coordination among the members of EUREKA on the topic of availability. Project manager: EUREKA Secretariat;
- Acropol for the development of tools to facilitate the informing of the general public interactively. Project manager: Bull;
- Maropt for a plankton-search system using underwater cameras. Project manager:Imf-Kiel. In France: Hytec;
- Cimis for the creation of a fully-automated farm. Project manager: Sagem;
- Ecma-Pcte for a software-engineering workshop environment. Project manager: Emeraude group;
- Visilog for the continuation of development work on an intelligent front end for data bases. Project manager: Bull/Cediag;
- Genesis for a system of cartographic data base management. Project manager: EGT (Holland); in France: Sagem;
- Irena for a telematics applications software-development workshop;
- Jamie for a software for the design of electronic components, in connection with the Smash simulator, on microcomputers. Project manager in France: Dolphin Integration;
- Atmosphere for real-time tracking of atmospheric emissions at industrial sites. Project manager: Tecsa (Italy); in France: Alcatel NTTT.

DEFENSE R&D

France's SAT Develops Infrared Detection System

92WS0739A Paris L'USINE NOUVELLE TECHNOLOGIES in French 16 Jul 92 pp 9,10

[Article by Thierry Lucas: "Infrared Surveillance Takes Over From Radar"]

[Text] The scramble-proof Vampir ML11 ensures the protection of warships during radar silence and detects water-skimming missiles.

On a warship under operational conditions, danger can arise from anywhere; airborne threats are the captain's particular nightmare. Increasingly sophisticated Exocet-type missiles are able to reach their objective while flying along the water's surface. To ensure the ship's security, infrared panoramic surveillance systems have become the indispensable complement to radar; their underlying principle is the fact that all objects emit electromagnetic radiation which is a function of their temperature. This is the case of Vampir ML11. Developed by SAT (in participation with CSEE) and now being validated by the navy, the device will be tested under operational conditions aboard the experimental vessel Ile d'Oleron.

Andre Delclaux, head of the VML11 project in SAT's Optronics and Defense Division, explained that "in an electronic warfare context, the infrared surveillance system has the advantage of being entirely passive. Therefore it cannot be scrambled and can continue to ensure the ship's protection during radar silence."

Installed at the top of the mast, the VML11 detection capsule containing the infrared sensor, performs two 360° sweeps per second. Its motion is totally independent of the ship's movements (the system is connected to the gyrometric station).

Within the ship, at the operator's console, the infrared panoramic "landscape" is displayed on four 90° strips. The most complex task of the surveillance apparatus is the very close analysis of these images in order to extract from them "tracks" or objects considered as threatening. The objective's coordinates are then transmitted to the ship's weapons system. Vampir ML11 can thus process over 100 tracks simultaneously.

Vital to security, VML11 must offer maximum availability. To ease maintenance, its four main parts (the detection capsule, its servomechanism, the electronic processing station, and the operator console) were designed with modular and decentralized architecture, for both hardware and software. About 10 16-bit and 32-bit microprocessors are distributed through the system; self-tests performed at the console verify the condition of the whole system.

As for the software, integration was achieved in one month thanks to independent and separately validated modules. It consists of a total of about 50,000 lines of C and C++ language, with some sections written directly in binary, in order to maintain very tight real-time constraints. VML11 benefitted from the software production method developed by SAT in collaboration with the consulting firm OPL. This approach resulted in a quality software manual designed to manage all development stages from specifications to integration testing. The VML11's capsule is a 95 kg technological jewel whose most minute details have been perfected and which receives the greatest care as it contains the sensor and is directly exposed to the elements. The number and size of the germanium optical components, which are transparent to infrared, have been kept to a minimum. The result is a sensor whose theoretical sensitivity is reached thanks to limited transmission loss and reduced sensitivity to thermal fluctuations. About a dozen probes continually monitor temperature variations, while defocussing due to material irregularities is automatically corrected by adjustment in the optics. Also, in order to prevent the destruction of all these capabilities, the capsule's port must retain a perfectly flat and flawless surface under all marine conditions. Germanium's electrical resistance provides defrosting without causing any warping to the port.

The infrared detector itself is cooled to 77 K by a Stirling-type closed-loop device. Two types of sensors are being used: with either an indium antimony base (InSb) for the 3-5 micron window, or a cadmium-mercury tellurium base (HgCdTe) for the 8-12 micron window. These two sensors are automatically recognized by the system and are interchangeable, including on board, depending on the ship's mission.

Beginning in 1995, the SAT infrared panoramic surveillance system will benefit from a new generation of sensors, the CCD strips marketed by Sofradir (joint subsidiary of CEA and Thomson). This will result in greater integration and resolution for the system.

Streamlined ACE Fighter Airplane Approved

92WS0779A Paris AFP SCIENCES in French 6 Aug 92 p 16

[Unattributed article: "ACE [European Fighter Aircraft]: Project Goes On With 'Lighter Version'"]

[Text] Madrid—On 4 August, in Madrid, the defense ministers of the countries participating in the ACE project decided to "continue" the program with a "lighter" version, at a cost 30 percent lower than the initial project, the Spanish defense minister, Mr. Julian Garcia Vargas, announced. The Spanish, British, Italian, and German defense ministers also agreed that an expert commission would establish the new military characteristics of the aircraft by 30 October, "based on the initial project" but "at a lower cost and with less advanced technology."

The unit cost of the interceptor could thus drop to somewhere between $55 million and $70 million, i.e. less than its most direct competitors, the American F-22 and F-15G. Mr. Vargas justified the four partners' decision by "the need to adjust to new European economic conditions."

In its first version, the ACE was to be produced by a consortium controlled 33 percent by British Aerospace, 33 percent by Deutsche Aerospace, 21 percent by Alenia, and 13 percent by CASA [Spanish Aeronautical Engineering Company]. The projected cost was about $100 million per unit, and $38 billion for the entire program, $9.5 billion of which were already spent. The new version of the aircraft will not be operational "before 10 to 15 years."

Rafale's M88-2 Engine Passes Endurance Test

92WS0795A Paris AFP SCIENCES in French 20 Aug 92 p 10

[Unattributed article: "Rafale: SNECMA's [National Company for Aircraft Engine Study and Manufacturing] M88 Engine Passes Its Endurance Test]

[Text] Paris—The future engine for the French Rafale fighter aircraft, SNECMA's M88-2, passed its official endurance test at the end of July, one month ahead of schedule, the French aircraft engine manufacturer indicated on 14 August.

In a communique, SNECMA emphasized "this important technical success," pointing out that the test, performed partly on the engine test stand and partly in simulated flight in the altitude chamber, is "essential to the progress of the M88 program."

This successful test will make it possible to go on to the next stage toward a series engine, late in September 1992. To date, the M88 engine has completed 3,800 hours of testing, including over 600 hours in flight. The engine will equip the Rafale C and M (air force and naval air force) to be set into service in France starting in 1996.

Health of Aerospatiale's Missile Division Linked to ANS Missile Program

92WS0802C Paris LE MONDE in French 9 Sep 92 p 24

[Text] The French Democratic Confederation of Labor, General Confederation of Management Personnel, General Confederation of Labor, and Workers Force unions of the Aerospatiale group have just written to defense minister Pierre Joxe. The topic of their letter is the "horrible consequences" of any move to abandon the antiship supersonic missile (ANS), which is being comanufactured with Germany. The unions consider that "the launch of the ANS is vital to Franco-German collaboration and the survival of the missiles division" at Aerospatiale. They fear that jettisoning the project, which is currently suspended by French decision (see LE

MONDE 7-8 June and 12-13 July), would result in a loss of know-how "concerning a propulsion technique that is usable on future civil supersonic craft."

UK, France Propose Joint Venture for Anti-Air Frigate

92WS0802E Paris LE MONDE in French 29 Aug 92 p 8

[Text] French and British defense ministers Pierre Joxe and Malcolm Rifkind agreed on Thursday, 27 August in London to ask their national weapons directors and navy chiefs-of-staff to deploy "every effort" to design a joint program for an anti-air frigate. A so-called "planning" office will open in the United Kingdom this year, to see to it that "maximal collaboration" between the two countries is established.

To escort and protect maritime forces, notably aircraft carriers, the ship will have to displace some 6,000 metric tons of water, do 27 knots in very rough seas, carry 215 crewmen, and be equipped with anti-air missiles, anti-missile missiles, and helicopters. The cost of one frigate would be about 3 billion French francs [Fr].

So far, discussions on how to harmonize the common operational needs of the two navies, divide the work between British shipyards and French arsenals, and determine the procedures for concluding various contracts on both sides of the Channel have proved difficult.

One long-controversial aspect now appears to be settled. After dropping out of the American program NAAWS, Great Britain has agreed to arm its frigates with a FAMS [family of anti-air missiles] anti-air weapons system marketed by the Franco-Italian consortium EUROSA. The FAMS program meets naval needs for local and medium-range defense. The British industrial partners [in the program] are British Aerospace and Marconi. As a participant in the EUROSAM consortium, Italy has the right to sit in as an observer to the current Franco-English meetings.

French, German Military Helicopter Upgrades Described

92WS0807E Brussels EUROPEAN AVIANEWS in English Jul-Aug 92 pp 34-35

[Article: "New Challenges"]

[Text] DAV—the DAV by Dassault Electronique has been flight tested on an SA 330 Puma by CEV. The cylindrical fairing on the test antenna, which is attached to the rotor head, is not representative of the production version. Inset: [not reproduced] a mock-up of the DAV (Search and Warning Device) antenna on the HAP.

TARGET, inset: [not reproduced] LCTAR had this life-sizing mock-up of a proposal for compact installation (on an aircraft or helicopter) of its TARGET surveillance radar for movements at long range. The Horizon demonstrator on a Puma during the Gulf War.

Were anyone to have looked for a stand that could be closely linked with the organisers' ambition to demonstrate Europe's vitality and solidarity in the face of international competition, then that stand was **Eurocopter**. For the first time at Satory, this company was presenting almost the complete range of military versions of helicopters made by its German and French subsidiaries. Eurocopter is the first example in Europe's aeronautical sector of a genuine transnational merger, and presented:

—the **Bo 105** in an upgraded antitank version of the German Army, equipped with 6 HOT2 missiles on lightened launch rails;

—two versions of the **Fennec, AS 550A2** and **AS 550C2**, surrounded by a wide range of light weapons, including four anti-tank missiles and four air-to-air missiles;

—the **AS 565AA/CA Panther**, a multi-purpose aircraft (tactical transport, support-fire, close-support) with a selection of axial weapons, such as two Giat 20 mm cannons, Forges de Zeebrugge (Thomson-CSF) 2"75 rocket-launchers, FN Herstal pod machine guns, or Matra's Mistrial air-to-air missiles;

—the **AS 532 U2 Cougar**, a life-size mock-up of the tactical transport version of the latest development of the Super Puma, with a maximum weight of 9,000 kg and capable of carrying 29 commandos;

—and last but not least of course, the **Tiger** (a 1:1 scale mock-up), the fruit of the important Franco-German combat helicopter programme developed in two versions: the anti-tank PAH2/HAC Tiger for Germany and France, and the HAP Gerfaut close-support derivative requested by the ALAT (French Army light aviation arm); the Tiger's antitank weapons will initially be for the Heeresfliegerei and will include the HOT2. At a later date, for both operators, the AC3G LP "fire and forget"-version with passive infrared CCD homing head (a barrel-launcher for four missiles was on exhibition in the form of a study mock-up) will be offered. In addition to this anti-tank equipment, the display included self-protection weaponry made up of Mistral air-to-air missiles for France, or Stinger for Germany. The Gerfaut escort/support-fire version is equipped with a Giat 30 mm gun-turret, Mistral missiles and unguided 68 mm rocket launchers.

The Eurocopter range (the most complete in existence) ensures that the world's second largest helicopter manufacturer can meet all major military requirements up until the end of the century at least. The design bureaus and marketing staff are, however, actively preparing the essential new products. That is always a dangerous exercise, particularly as there is today so much uncertainty over future army budgets throughout the world. And this also applies in the short term.

Equipment and armaments. It is not feasible within the space of a report to describe, nor even to mention all the

equipment and weapons manufacturers that were exhibiting at EuroSatory in the military helicopters field. We will return shortly to the subject in our "Helicopter Special" in November. Therefore, we will limit ourselves here to mentioning a few representative examples of rapid technological developments in terms of "accessories" for military helicopters.

At Dassault Electronique, the DAV [Search and Warning Device] is a doppler pulse radar whose antenna is mounted securely onto the rotor head, giving the system a 360° coverage. The DAV is designed to detect, identify and track threats up to a range of 9 km, such as helicopters in tactical or hover flight, as well as aircraft flying at low altitude. A demonstrator mounted on an SA 330 Puma belonging to CEV of Bretigny was used by STAT of Valence for an operational evaluation of the system.

At Euromissile Dynamics Group, the third generation long-range anti-tank **AC3G-TRIGAT** missile will arm Eurocopter's Franco-German Tiger. And it will, in theory, be used to equip the future UK combat helicopter—which has yet to be selected. Launched in 1988, the complete development of the missile has now reached the testing phase for individual sub-systems. Nine ballistic firings were carried out at the beginning of this year.

Giat Industries presented its 30 mm **Type 30M781** gun-turret, developed for the close-support Gerfaut. The development is in the final phase of ground rating with, in particular, firings in continuous bursts at 300 shots/minute. The turret made its first flights under the nose of a Puma. The opening of the flight envelope on a Gerfaut prototype should begin shortly and lead to firings in 1993.

The company **SERAT** (Societe d'etudes, de realisations et d'applications techniques) is a French specialist in the field of military warheads for missiles and rockets, anti-tank systems and anti-proximity fuse munitions protection. Under contract to MBB, it is developing the forward projectile for the tandem modernised shaped charge on the HOT3, which will in future be made up of a small finned warhead, launched before impact with the reactive armour. Also working under contract to MBB, SERAT is participating in the development of the shaped charge and weapon security of the AC3G missile by EMDG. In the "intelligent" mines field, the company offers an anti-helicopter mines system.

At Thomson-CSF (Electronic Missiles division), the company presented its infra-red imaging system seeker of the AC3G-LP missile. Developed under the prime contractorship of British Aerospace, in collaboration with BGT and Thomson-CSF, the IR seeker provides the missile with a fire-and-forget capability, which ensures an autonomous tracking of the target (static or moving, tank or helicopter) throughout its trajectory, both at night and during the day.

Thomson-LCTAR exhibited its x-band, type MTI (Moving Target) **TARGET** family of radars. These are used for surveillance of movements at long range. The best known of the Target systems is undoubtedly the heliborne **ORCHIDEE/HORIZON** equipment: the demonstrator carried on a Puma successfully took part in 24 data gathering and target acquisition missions during the Gulf War (see Aviastro October 1991). LCTAR exhibited at EuroSatory an example of the compact installation of TARGET for an aircraft or helicopter, and showed a simulated projection, on an electronic map background, of the data gathered by radar and processed by the digital signal processor.

ENERGY, ENVIRONMENT

Germany: Activated Coke Filters Purify Incinerator Emissions

92MI0691 Wuerzburg UMWELTMAGAZIN in German No 8, Aug 92 pp 50, 51

[Text] The Raw Materials Salvaging Center (RZR) in Herten (Recklinghausen district) does not merely adhere reliably to the stringent limits of the 17th Federal Pollution Control Order, but is actually obtaining values well below the limits, and this even applies to the emission limits for dioxins and furans. This was the conclusion drawn after the comprehensive measurement tests carried out on behalf of the Ruhr District Waste Disposal Company (ACR) into the first large-scale activated coke-based flue-gas purification system in Europe to be located downstream of an industrial waste incineration plant. The results of the measurements were presented for the first time at Envitec '92.

As the operator of the Herten RZR, the AGR had brought the "police filter" into service in August 1991 and had it monitored, right from the trial phase through to its present continuous operation, by a scientific measurement program carried out by the IUTA [Institute of Environmental Technology and Environmental Analysis] at the University of Duisburg. The emission values of the Herten RZR, which were already regarded as exemplary, have been even further reduced by using the additional filter downstream of industrial waste incineration line 1. This applies in particular to the dioxin value, quoted in toxicity equivalents (TEs), for which the 17th Federal Pollution Control Order prescribes a maximum of 0.1 nanograms m^3 of pure gas. Professor of Engineering Klaus-Gerhard Schmidt, head of the IUTA, announced that incineration line 1 at the Herten RZR achieved a daily mean of 0.02 ng/m^3 of flue gas. According to Schmidt, the measured values for "total dust" and heavy metals are sometimes below the limits of detection (see table).

Taken overall, these emission values may be unique among industrial waste incineration plants worldwide. Not just the environment-oriented specialists but also, and above all, the members of the German industrial

plant engineering sector involved in environmental protection from the technology being tried out by the AGR.

The new filters were added to the existing flue-gas purification system of electrostatic filters and two-stage wet washing at the Herten RZR, which started operating in 1991. In the first stage, the activated coke filter precipitates acid flue gas components such as SO_2, HCl and HF, and also uses lignite-based open-hearth furnace coke to precipitate heavy metals and dioxins/furans. Nitric oxide is reduced in the second stage, using ammonia as the reduction agent. Hard-coal based activated coke serves as the catalyst. The capacity of the plant is approximately 70,000 m^3/h of flue gases.

There is another innovation too. Frustating residue disposal problems such as those encountered, for example, with charged activated coke from domestic refuse incineration plants, do not arise. The charged coke from the first post-purification stage is burned in the upstream plant, degrading dioxins and precipitating heavy metals in the two-stage wet washing system.

A further advantage of the activated coke technology supplied by the Hugo Petersen company of Wiesbaden that the filter exerts a compensating effect on fluctuations in the pollutant concentration in the raw gas. The high adsorption capacity of the solid bed with its coke flue acts as a buffer, which operates well below capacity. (1 g activated coke has an adsorbent surface of 300 m^2).

From now on, the Herten RZR will publish its emission data on a regular basis. This has never been done before in the land of North-Rhine Westphalia. Activated coke technology is scheduled to become a statutory requirement for all existing and planned waste incineration plants in this land by the end of 1995 according to the Emission Reduction Schedule for Dioxins From Waste Incineration Plants in North-Rhine Westphalia (EMDA).

AGR, the leading German disposal company, has adopted this promising technology for the hazardous waste incineration plant at the RZR in Herten, demonstrating once again the Ruhr district's pioneering role in matters of environmental-compatible disposal.

At a total cost of more than 170 million German marks [DM], the two domestic waste incineration lines at the Herten RZT will also be fitted with this state-of-the-art filter technology by the summer/fall of 1993, with the second industrial waste incineration line following suit by the end of 1995.

Table: Emission Values (in mg/m^3) for Industrial Waste Incineration Line I at the RZR, Herten

Statutory Emission Limits	In accordance with the 1986 Clean Air Act		In accordance with 17th Federal Pollution Control Order		Daily Mean Achieved at the RZR, Herten Dec 91-Feb 92
Mean values	Daily Values	Half-hourly values	Daily values	Half-hourly values	
Total dust	30	60	10	30	< 1*
ΣC_{org}	20	40	10	20	< 2
CO	100	200	50	100 Hourly average	25
HCl	50	100	10	60	< 2*
HF	2	4	1	4	< 0,5*
$SO_2(SO_2,SO_3)$	100	200	50	200	8
$NO_x(NO, NO_2)$	500	1000	200	400	120
Heavy metals:					
Class I	Σ 0,2 Hg, Cd, Tl		Σ0,05 Cd, Tl		<0,007**
			0,05 Hg		Σ0,002*
Class II	Σ 1,0 As, Co, Ni, Se, Te				
Class III	Σ 5,0 Pb, Sb, Cr, Cu, Mn, V, Sn		Σ 0,5 Sb, As, Pb, Cr, Co, Cu, Mn, Ni, V, Sn		Σ0,2**
Dioxins and Furans asΣTE	not taken into account		0,1ng/m^3		0,024 ng/m^3

* below the measurement limit

** below detection limit in some cases

Germany: Biofilters Used to Degrade Air Pollutants

92MI0692 Wuerzburg UMWELTMAGAZIN in German No 8, Aug 92 pp 52, 54

[Text] Stricter statutory regulations are facing many companies with the problem of having to reduce the extent to which their storage and production facilities discharge polluting and malodorous substances into the air, or preventing such discharges altogether. For two years, the Bremen disposal firm Zipfel GmbH & Co. has been using Biovar filters made by Kessler & Luch GmbH of Giessen to reduce its emissions. With these systems, the substances to be removed are adsorbed by an organic filter material, and degraded by adapted microorganisms into CO_2, water, and biomass. This process requires no additional chemicals, and no secondary pollution is produced in the form of effluent or solid waste products. The application areas for this technology range from agriculture through animal and vegetable raw materials processing to use in solvent-processing factories and the chemical industry.

Odor Limits Must Not Be Exceeded

Zipfel GmbH was established in 1945 as a hauling contracting company, and developed into an operation specializing in cleaning and disposal work. Its services include, for example, the reprocessing of sands containing mineral oils from sand traps, the cleaning of industrial tank systems and industrial separator systems, and the treatment of contaminated fuels and oils, grinding emulsions, laboratory chemicals, and old varnish. The company also empties septic tanks and grease collectors, and cleans and monitors sewage systems (with remote-controlled, self-propelled cameras).

In 1990, the firm acquired a refuse treatment plant in accordance with the public works planning procedure. However, there is a ceiling on the concentration of the odors emanating from the incoming garbage that can be released into the ambient air. According to works manager Heinz-Joachim Badenhoop: "Whereas the odor emission problem used to be "solved" by dilution with air, such facilities are now rationed to specific odor units that must not be exceeded." In order to meet the new requirements, the company had Kessler & Luch's environment-friendly Biovar filters installed for the thin and thick matter reception area at its waste disposal plant.

Maximum Efficiency as a Result of Accurate Design

Because the Biovar filter needs to be tailored as accurately as possible to the requirements of the particular application, the first step is to analyze the raw gas data. This provides information on the nature and volume of the substances encountered. In Zipfel's case, these were mainly substances typical of disposal companies, such as BTX aromatic compounds (benzene, toluene, xylene) or short-chain aliphatic hydrocarbons. On the basis of this information, the air pretreatment, flow rate, filter material, and microorganisms are precisely tailored to the components to be degraded. This method achieves the greatest possible filter efficiency.

In the light of the data obtained, four Biovar filters, each with a filter area of 14.9 m^2, were installed in sliding sedimentation containers. They are connected in parallel, so the fumes requiring treatment flow evenly through all the filters. The containers have the advantage of being light to transport and quick and flexible to install.

The intensely odor-laden air is firstly carried via a duct system to be pretreated in an upstream processing unit. As the living organisms require certain environmental conditions for optimum degradation, the air is adjusted to the requisite conditions by humidification, degreasing, dedusting, or cooling in this unit. At Zipfel, only humidification was necessary. An exhaust humidifier brings the air to a relative humidity of approximately 95 percent. To compensate for temperature variations, a heating system can be connected if required.

The pretreated air is then conveyed to a pressure chamber below the filter material, whence it flows through a lath floor with ventilation slots at an air throughput rate of 2,000 m^3/h per container and passes evenly through the filter layer. A bark humus, composted by a special method and prepared with microorganisms specially selected to degrade the substances encountered, is used as the carrier material. Depending on the requirements, heather, turf, cut root wood, or a combination of various materials can be used. Comprehensive tests are carried out to determine which material is best suited to which group of substances. The information obtained in this way ensures the optimum choice of the type and grain (important for the filter surface) of the carrier material and microorganisms.

The substances adsorbed by the carrier material are degraded by the microorganisms into CO_2, water and biomass. The biofilters operate very flexibly. Their carrying capacity is so great that even peak loads do not impair their efficiency. Although the degradation capacity is greatest with pure components, the lower level of efficiency obtained with mixtures of substances can be offset by increasing the filter volume and/or reducing the throughput rate. Fresh air also flows through the filters to keep the microorganisms alive. The purified gas flow is discharged from the filters without any further treatment.

The natural cleansing process requires no additional chemicals. Nor do pollutants accumulate in the filter material causing secondary pollution. According to Ute Haberberg, a biologist at Zipfel, this is a crucial advantage compared with other methods such as biowashers or activated carbon, where: "The substances that are filtered out are stored in the filter material, creating a new disposal problem. At Zipfel, when the filter material has to be changed, which will probably be in four years' time,

it will merely have been enriched with biomass (proteins and cell water), and can even be used as garden compost."

High Air Exchange Rate Prevents Build-Up of Explosive Atmosphere

Biovar filters fulfil yet another function. As some of the substances delivered may be expected to give off inflammable benzene vapors, anti-explosion measures must be installed in the areas concerned. The filter system, which continuously extracts the polluted air from the hazard areas, gives a high rate of air exchange, which prevents an explosive atmosphere from building up. So, in addition to the statutory safety measures, these filters also play a part in explosion prevention.

The city of Bremen has also opted for the biofilter system. It needs a highly efficient, environment-friendly system to cope with 52,000 m^3/h of air at the large-scale sewage treatment works at Bremen-Seehausen. Transportable, container-mounted filters cannot handle a requirement on this scale, so Kessler & Luch have decided to supply Biovar filters in large-capacity concrete housings. Together, the four filters in Seehausen will have an overall filter surface of 360 m^2.

BASF Company Developing Plastics Recycling

92WS0702A Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German, 13 Jul 92 p 10

[Article by Arno Noeldechen]

[Text] The present situation in the plastics business has made it difficult to calculate and plan even for the management of the BASF combine. Present conditions include low sales growth, political threats against plastic packaging, a welcome growth of plastics in automobile production, further development of technical plastics, which have good sales prospects, overcapacities in the field of most mass-produced plastics, which are resulting in lowered returns, and market-driven expansion of production capacities at home and abroad.

On the one hand plastics are accepted as problem-solvers, and on the other hand concern is growing about their disposal and reprocessingg. The picture becomes even more confused, since, in addition to what already exists, further government intervention and regulation can be expected. This primarily relates to tightening of environmental protection measures.

Market development for plastics is nonetheless optimistically viewed at present by BASF AG, for after two years of stagnation in standard plastics market figures are again clearly on the rise. Thus in the West during 1991 about 94 million tons of plastics were consumed. Of these BASF produced about 2.7 million tons. Its share of the market is thus almost 2.9 percent.

While the price decline and sales could balance each other out in a relatively short time, the recycling and reprocessing mainly of mass-produced plastics is a challenge to manufacturers, processsors, and to our entire society. There is no doubt that controlled incineration of plastic waste with recycling of the thermal enegy is a technically feasible. It is more widely used by our neighbor, France, than it is here. In Germany it is the subject of controversy.

BASF AG in Ludwigshafen, according to its own statements, intends to try everything it can to reduce the amount of plastic waste and to promote its utilization. Dr. Juergen Hambrecht, director of the plastics division of the company, announced the opening of a special technical institute, which is to occur this year. Equipped with all the appropriate facilities, it is supposed to develop all operational and procedural techniques necessary for the reprocessing and utilization of plastic waste.

In the plant of the institute, all operational and procedural techniques for the reprocessing or reutilization of plastics are to be developed and tested, as a means of coping with the emergent mass of plastic garbage. This intiative should benefit the plastics processing industry, which is a direct customer of the company.

In recent years marked progress has been made in the recycling and reprocessing of plastic garbage. The laboratory or technical institute plants, however, until now have simply been too far removed from market reality to have any visible effect on the garbage dumps, and on the German population in terms of an altered awareness of the problem. At the present time three methods of reutilization of plastic waste are in use—recycling it into new products, burning it as a substitute for fuel oil, or chemical recycling into reusable starting materials for the synthesis of plastics.

Dr. Karl-Rudolf Kurtz of the Plastics and Environment Department of BASF explains that at present the reprocessing of materials into new products is the most common method. In its range of products, BASF now carries a number of recycled plastics—polyamides, ABS [acrylo-butadiene-styrene-copolymer], and polystyrene. The reprocessing and conversion of these plastics can be done successfully, however, only if parts that are clean and sorted by type are available in sufficient numbers. These preconditions in fact apply only to a relatively small number. In other words the problems of cleaning and sorting remain unsolved.

Today some polymers, in addition to being separated according to thickness and buoyancy by means of hydrocyclones, are also sorted automatically by electrostatic methods. This depends on how strongly a polymer can be electrically charged and then can be diverted in a high-voltage field according to its positive or negative charge. This is indeed a fine method, but unfortunately it can't be used with all mass-produced plastics.

Each of the charged scraps of plastic then drops on to the backplate electrodes. In addition to this, the charge can also be increased by pretreating the surfaces. This electrostatic reprocessing or separation method, abbreviated Esta, is already being used on mixtures of polyethylene and polyvinyl chloride (PVC). A research plant of the subsidiary company Kali und Salz AG is at the present time achieving a throughput of up to 100 kilograms per hour. It is supposed to have an annual capacity of up to 20,000 tons.

This method works, for example, in separating mineral water bottles made of PVC and polyethyleneterephthalate (PET). Practical experience shows that in a two-stage treatment separation can be achieved which is up to about 90 percent type-pure. There are also types of waste whose reprocessing in the view of the chemical industry is not very "sensible." The waste is too mixed up and dirty, or there are no reliable collection methods. In other cases the reprocessing procedures are uneconomical, since their costs far exceed those of newly synthesized plastics.

Finally "endless" recycling is impossible, since with each new reprocessing the properties of the material deteriorate. Therefore with this type of material an attempt is made to arrive at so-called raw-material recycling. This means in terms of processing technology that the garbage must be so liquid that to a certain extent it can be pumped like oil.

A technical institute plant designed for this purpose uses methods of plastic processing to melt the garbage in an extruder, and then to heat it up even more. In this process a number of the chemical bonds of the polymers break down, the molecular weight is reduced, and the material acquires a lower and more manageable viscosity.

In a division of a hydrogenation plant in Bottrop, it was demonstrated that the oil-type polymer can be converted to synthesis gas components in an oxidizing atmosphere. From this, new plastics can be created, since methanol or ammonia are formed, which can be used for new syntheses. The Company for the Development of the Reutilization of Plastics will shortly begin operation of an appropriate technical insttute plant in Leuna, which will be converted from an already exisiting plant and will be used to produce synthesis gas.

When the chemical bonds of polymers are broken down thermally in this way, energy costs accumulate. In the case of large masses of waste, this could also add substantially to the price of the original monomers, and it is probably more expensive as a method than the previously used syntheses from the mineral oil component naphtha.

Rather incomprehensible for this reason is the negative attitude of industry towards the presently known possibilities—particularly in the case of the mass-produced plastics PVC, polystyrene, polypropylene, and polyethylene, which are now being discussed—of simply dissolving them in suitable solutions, and producing new plastics directly from this process. One patented method can manage this even without expensive sorting, and from a mixture of these materials turns out pure, reusable plastics in individul type-sorted fractions.

The price difference between newly synthesized plastic and recycled plastic levels out if suitably large plants are established. From what is presently known, however, the above-mentioned BASF technical institute will not concern itself with this important reprocessing technology.

Despite these difficulties the development of new plastics continues unabated at BASF. For the current fiscal year about DM300 million is available for research and devlopment in this field. Involved here is the group of so-called technical plastics, which can withstand a greater amount of heat or have better mechanical properties than the plastics which are presently being sold. This applies to polyther-sulfone and polyther-ketone among others.

Siemens Power Engineering, British Nuclear Fuels To Collaborate on Mixed-Oxide Fuel Element Plant

92MI0725 Bonn DIE WELT in German 29 Aug 92 p 12

[Text] Siemens's power engineering subsidiary (KWU) is currently negotiating with British Nuclear Fuels Ltd. (BNFL) with a view to building a mixed-oxide [MOX] fuel element production facility.

KWU spokesman Wolfgang Breyer stated in Erlangen on Friday that the plant would be on the scale of the new Siemens fuel element works in Hanau. The Munich group put the costs of the facility at around 700 million German marks [DM]. Breyer stressed that the Siemens subsidiary would not be going it alone. KWU would not be building the complete facility, but would solely be rendering technical assistance at the planning stage to BNFL, which already operates two reprocessing plants in Sellafield, England.

"We are ready to make our technology available," said the spokeman, although contractual agreements to this effect had not yet been concluded. According to KWU, the British company intends its MOX plant to serve the world market. The British saw Japan, in particular, as a major customer.

Siemens is regarded as the leader in mixed-oxide systems processing technology. Breyer dismissed speculation that the British plant was a possible alternative to the MOX factory at Hanau, the completion of which is currently being blocked by the government of the land of Hesse. "Under no circumstances are we prepared to back out of Hanau," he said.

Breyer also explained the reasons. Siemens could not simply write off investments of DM700 million. Also, the British plant might be a very long time in coming. As in Germany, the licensing procedure and construction work would take years.

According to Siemens, the new fuel element plant at Hanau has been designed for a 120-tonne annual output of MOX elements. This meant that the plutonium produced each year in all 20 German nuclear power stations could be reprocessed.

European "Forum for Future Energy" Urges Technology, Capital Transfers to Developing Countries

92WS0727B Duesseldorf VDI NACHRICHTEN in German, 26 Jun 92 p 30

[Article by Lutz Bloos]

[Text] A European energy policy which is completely oriented to environmental problems was recently called for by the Bonn Forum for Energy of the Future. Included in this was also the matter of the CO_2 tax.

Shortly before the beginning of the UN Conference for Environment and Development in Rio de Janeiro, the Forum for Energy of the Future was held in Hamburg. The forum, which was initiated two and a half years ago by the Federal Ministry for Trade and Commerce, has about 250 members, which include associations, firms, and leading figures from the energy industry. In a declaration some 100 participants from 18 countries formulated their demands for a European energy policy.

Energy-supplying enterprises will be asked to commit themselves to making a lasting reduction of CO_2 emissions and other harmful substances affecting the environment. This should take place at first through a more rational use of primary energy carriers, and then increasingly through the use of regenerative energy sources. If the energy-saving potential of the industrialized countries is exhausted, "investments in reduction measures in eastern and southern European countries are available, as they also increasingly are in the developing countries." In addition to this, energy combine systems should be created, which make possible a more efficient use of resources, especially in southern and eastern Europe, in that they even out the cost structures.

The energy industry should commit itself to "offer only such energy technologies as are in accord with the most recent level of emission-reducing technology." The further development of these technologies should be given a strategic priority in the range of products offered by the suppliers. The opening of new markets for these technologies would be facilitated by means of joint ventures and technology transfer.

In order to preserve energy reserves within the EC the declaration calls for a European CO_2 tax. The tax revenue should be used for measures relating to environmental policy. "Businesses which are liable to the tax should be released from the tax if they carry out measures internationally which fulfill their commitment to the reduction of CO_2," the declaration states. The remaining tax revenue should be placed in a fund which gives support to innovative projects. The support should be in accord with attainable measures for the alleviation of damage to the environment.

Dr. F. Wilhelm Christians, chairman of the committee and also chairman of the board of directors of the Deutsche Bank and the RWE, pointed out that "damage to the environment must have a price, and those who cause it must be charged in the long term for the full costs of environmental consequences. To be sure, this principle would have to be coordinated internationally, in order to guarantee equal chances to all the participants." On the subject of nuclear energy, he called for an agreement as to its further use, since otherwise the effect of reducing CO_2 would again be destroyed. Christians regretted that "in Germany the subject has up until now been handled too ideologically."

A further demand put forward to the European Community by the declaration is for a long-term and continuing program for introducing to the market and distributing renewable forms of energy. The program should put industry in a position to push forward developmental work, to develop market strategies, and to expand production capacities. In this way cost-favorable mass production should become possible. In addition to this the EC countries should also persuade the other industrialized countries to join them in these measures.

For the countries of the third world, who are presently paying three times as much interest to the industrialized countries as they are receiving from them in developmental assistance, debt conversion programs will be called for. This means that in exchange for energy-saving and environmental programs debts will be forgiven. The EC should also advise and assist these countries in the correction of energy markets and the creation of suitable legal guidelines, just as they do other third world countries, as for example the former RGW countries.

Christians expressly supported this aspect: "Without a transfer of capital and environmental technology we can expect no commitments from the southern countries as to measures for the protection of their own environment and climate—for example the protection of the rain forest." However the requirement which this would obviously entail was qualified by Christians, who remarked: "A rapid changeover in energy policy is not possible and also not desirable, especially not for the emergent industries of the developing countries."

The forum made two things clear—that the German business world has recognized the necessity for effective measures for the protection of the climate, and that it

intends to play an active part in their realization. But the emphasis on the fact that all activities must be coordinated internationally, or at least in Europe, also shows that it rejects German unilateral actions as causing uneven competition.

However Dr. Edda Mueller of the Federal Ministry for the Environment pointed to another relevant fact—namely that the internationally successful industry of Japan had to operate with higher energy costs than any of the EC countries, while on the other hand the U.S., which is weak in exports, would produce with much lower energy costs than the Europeans. International competitiveness is thus not dependent on the cost of energy.

Dr. Wolf Rasch, Secretary of the Forum for Energy of the Future, is not afraid that an additional energy tax would harm the German economy. He demands "more pressure" from the government, for he believes that energy consumption will only be reduced as a result of the price, and adheres to the old saying: "He who pays more will use less."

In order to further its ambitious goal of reducing CO_2 emissions by 25 percent by the year 2005, Edda Mueller explained, the federal government has introduced a series of measures. Among these are the amendment of the heat insulation and the heat utilization ordinances, as well as a revision of the schedule of fees for architects and engineers. In the planning stage are also energy labels for equipment and the setting up of energy agencies, which would give advice to consumers. Further measures are being worked on. The participants of the forum, nonetheless, took a cautious view of the government's goal. Christians therefore merely asked that energy consumption in the industrialized counties be kept at its present level, and that increases in consumption in the third world be limited. Anything else appeared to him unrealistic.

German Institute Develops Alternative to Diesel Engine

92WS0728A Duesseldorf HANDELSBLATT in German 23 Jul 92 p 19

[Article by Bernd Genath: "New Motor for Block Heating Power Stations: Oil-Gas Engine/Juelich Research Institute: Clean Alternative to Diesel"; first paragraph is HANDELSBLATT introduction]

[Text] 22 Jul (HANDELSBLATT)—Since the successful test run of a prototype at the Juelich Research Institute GmbH (KFA [Nuclear Research Facility]), there has been a show of optimism for an efficient alternative to today's diesel principle—more efficient in output, displacement, and pollution reduction. The new variant can best be described as an oil-gas engine: The diesel/air mixture is not prepared in the cylinder in the conventional way but rather the fuel is vaporized outside the cylinder in steam. The injection nozzle then injects the mixture into the precompressed combustion air.

Thus, in comparison with the conventional diesel, totally different starting relationships are present for the subsequent combustion—because the injected oil-gas is composed of approximately two parts steam and one part fuel. In principle, fuel engineers have long known that heating oil/water emulsions guarantee cleaner combustion than burning fuel alone: The small water droplets vaporize faster when heated than does the oil; the vaporizing water particles rip the associated diesel particles apart explosively and atomize them ideally—resulting in good combustion.

The advantages are described as follows in the literature: more complete combustion, less soot formation, lower nitrogen oxides. However, with the conventional diesel engine without external vaporization oil/water emulsion results at best in lower nitrogen oxides, but the efficiency of the engine drops. In contrast, with oil-gas the combustion pluses are best achieved, with the additional bonus of increased engine efficiency. More complete combustion and less soot because of the excellent mixing, because oil molecules are added to the steam molecules upstream of the injection nozzle and thus no liquid droplets, just steam molecules, are shot into the combustion chamber at the speed of sound.

The mixture burns as soon as it is injected into the combustion chamber without any ignition lag and without the otherwise very fertile sooty zones around the fuel droplets. The successful suppression of soot can also be traced to the attack of the water molecules on the fuel molecules. HO-radicals are produced in this partial decomposition, and it is known that they minimize the formation of soot.

The reasons for the reduced nitrogen oxide output are obvious: NOx emissions increase with rising combustion temperatures; in contrast, the steam in the oil-gas engine lowers the combustion temperature by 200-300°C.

Even the local temperature peaks, which appear in the conventional process in the region of the injection nozzle and on the boundaries of the flame because of incomplete mixing, are absent. These peaks favor nitrogen oxides even in very lean engines with high excess air values. The oil-gas engine eliminates these problems relatively elegantly.

And finally, the improved efficiency of the engine is a result of optimal combustion and of the steam which is present as a coolant during combustion, delivering more energy to the piston in the power stroke and yielding less energy loss.

With regard to excess air: The conventional diesel system operates with lambda numbers 1.5 through 3, i.e., 1.5 to 3 times more parts per volume of air per part fuel are required than are theoretically needed for oxidation. Only at these concentrations are engine builders on the safe side of halfway environmentally sound combustion with tolerable soot formation. Gasoline, with a largely homogeneous mix produced before combustion gets by with significantly less air. For the diesel process this need

for more air first means lower efficiency relative to displacement or in other words: low energy content of a highly air-enriched mixture.

Consequently, the performance of a diesel engine is significantly lower than that of a gasoline engine with the same cylinder volume. Attempts to increase the efficiency relative to displacement in the diesel engine led to the exhaust gas turbo-supercharger. This trick is not needed with the oil-gas engine because it gets by with much lower quantities of air anyway, i.e., close to the stoichiometric ratio. This and the improved efficiency increase the mean pressure in the cylinder and thus its output per unit of displacement.

Second: The normal form of the diesel engine is not only large in volume, but also very heavy. This is primarily because of the fact that for ignition of the injected diesel fuel the air heated to this ignition temperature of 600-700°C must also be precompressed so that, if possible, the injected fuel vaporizes without any ignition lag. For this the compression ratio must be 15 to about 20, whereas a gasoline engine makes do with 10 to 12. This high compression in turn requires massive construction. Because of the immense load on the engine from the very high combustion pressures up to more than 150 bar, engineers have to provide thicker material everywhere. Thus, according to experience a diesel engine weighs roughly twice as much as an Otto engine.

The higher compression ratio helps efficiency to a certain extent, but the improvement is not linear. It would be ideal if a diesel engine with lower compression but equally high efficiency could be created. Then its weight could be cut. Oil-gas permits this. Ignition occurs at a compression ratio as low as six, and with the completeness which the conventional variant does not obtains until it reaches a compression ratio of more than 15.

Experiments at Juelich revealed the basic capability in the course of the carbon dioxide discussion and in the search for a conventional diesel with reduced pollution. As a side effect, this route also relieves the engine of its stress even with improved efficiency. However, this modification can be obtained only at increased cost. This occurs first in the vaporizer—because the oil-gas principle is an autothermal process, i.e., it can operate without additional outside energy. The calories needed to vaporize the water and the oil are drawn from the exhaust gas via a heat exchanger in the exhaust line.

Second, the engine must be retrofitted for oil-gas injection. Third, it is necessary to use desalinized water, and, fourth, this requires cooling the exhaust for recovery of the condensate. Fifth and last, the actual autothermal process does not start without short-term preheating of the vaporizer. This requires an external heating system for the start phase of 1 or 2 minutes.

The increased cost is offset by the savings for the exhaust gas turbo-supercharger, a soot filter, or an exhaust catalyzer—all expensive components. The researchers at Juelich are no longer discussing basic technical problems. It is now time to hand over the principles developed to a competent engine builder to complete development under industrial conditions. The successes to date have been limited to small engines with single cylinder engines and displacements between 50 and 280 cc, which have in principle pointed the way to the oil-gas injection diesel with environmentally safe and energy saving combustion.

The new technology lends itself—because of the necessary additional components—more specifically to stationary engines, for example, in block heating power stations. Here, there is currently a conversion to gas engines, because the gas engine does not produce soot. The additional service which a diesel engine constantly requires to suppress these pollutants means that diesel fuel is not exactly the fuel for this modern form for generation of power and electricity. However, this again binds the operator to a supplier, to rates, to a gas line, and the like. The oil-gas process would offer block heating power station operators a completely different system.

Siemens To Build Plutonium Recycling Plant in Russia

92WS0736A Duseseldorf VDI NACHRICHTEN in German, 3 Jul 92 p 3

[Article by Martin Schneider]

[Text] The new disarmament agreement between President Bush and Yeltsin counts as a great step forward. The arsenals of both sides are to be reduced to 3,500 warheads each. But what is to become of the refuse of the Cold War, the radioactive explosives of the warheads?

For four decades the great powers confronted one another, rattling their sabers. No exact details are known about the the number of missiles and warheads which were deployed during the arms race, but experts agree on one thing—that with disarmament comes a new and urgent problem: What is to become of the plutonium and highly enriched uranium from the warheads of the missiles? According to Frank von Hippel, a disarmament expert at Princeton University: "In the countries of the former Soviet Union we must expect there to be 100 tons of plutonium and about 400 tons of highly enriched uranium." What becomes of it must now be decided by the governments of Russia, Belarus, Kazakhstan, and Ukraine.

According to the reports from western observers at a conference in Bonn at the end of June, a large part of the deadly arsenal is presently on Russian territory. "Disarmament so far has only consisted of unscrewing the electronic fuzes," Anette Schaper of the Hesse Foundation for Peace and Research on Conflicts (HSFK) in Frankfurt reports. At various sites the weapons are awaiting complete dismantlement. A giant bunker with a 50,000 m^2 storage area is supposed to be built near the

Russian city of Tomsk as an interim storage facility for all of the weapons components.

"The individual weapon components must not be stored in such a way, however, that they can simply be taken back off the shelves and used to piece togther an atomic bomb," Albrecht Mueller of the HSFK warns. In this case he is not thinking of possible terrorist attacks, but primarily of the danger of an unforseeable drastic political change in the still young eastern republics. For this reason in Bonn Mueller recently called for inspection by the International Atomic Energy Authority, the IAEA, in Vienna. In this demand he was supported by representatives of the political and business worlds.

Mueller believes that in principle the officials of the Russian Atomic Energy Ministry, Minatom, have no objection to international supervision. However they impose one condition—that the western nuclear powers must also allow "watchdogs." Until now, however, they have shown no interest in this.

While the construction of the interim storage depot in Tomsk to a certain extent seems assured, it is still undecided what should ultimately become of the nuclear scrap. "It is important that as many barriers as possible be set up in order to prevent nuclear weapons from being used again," Albrecht Mueller requested.

"The simplest solution would be to melt down the plutonium into glass, and then to place it in final storage sites," Frank von Hippel suggests. This method has already been tested for radioactive waste; it remains only to build a glass factory with the necessary capacity. The only "disadvantage" of melting it down, according to von Hippel, is that the plutonium could no longer be used as fuel.

This is exactly what German industry is proposing. The explosive waste could also be used for non-military purposes—this according to Peter Schmiedel, director of the Siemens fuel element plant in Hanau. The plutonium could be gradually consumed in the nuclear reactors of the CIS in the form of "mixed oxide" (MOX) fuel elements. The normal fuel of a nuclear reactor consists for the most part of natural uranium-238, up to about 3 percent of which is enriched with the fissionable uranium isotope-235. In the presence of mixed oxide elements a part of the uranium-235 is replaced by plutonium oxide, and the enrichment level is also increased. The MOX elements can then be used in nuclear power plants like conventional fuel rods.

"Within three years we can build a duplicate of our Hanau MOX plant somewhere in Russia," Schmiedel suggested at the conference in Bonn. This duplication would be the cheapest solution and also has the advantage that the time-consuming licensing procedures could be eliminated, according to Schmiedel. To be sure, Siemens will not bear the DM700 million costs. This, according to Schmiedel, is the job of the politicians.

In the Hanau duplicate, according to Schmiedel, 5 tons of plutonium from weapons could be processed annually into a total of 120 tons of fuel elements. The two other MOX producers, the French firm Cogema and Belgie Nucleaire, are also hoping for a piece of the disarmament pie—so it was reported at the conference in Bonn.

In the Darmstadt Ecological Institute they don't think much of the idea of slowly burning up the weapons plutonium in the form of MOX elements in Russian nuclear power plants. "This would be irresponsible for reasons of safety," Britta Nockenberg protests. "The pressure vessels of the Russian VVER-1000 reactors have a tendency to become brittle as it is; the hardened neutron radiation which occurs with the MOX elements would only exacerbate the problem"—this the electrical engineer knows. "The VVER-430 [sic, VVER-440] series needs to be broken off anyway, since it has inadequate cooling systems and no containment building." Moreover melting down is about 10 times cheaper. The dilution of 100 tons of plutonium into MOX elements could scarcely be done for under DM10 billion.

Schmiedel, the director of Siemens, also knows that the conversion of weapons plutonium into MOX elements is not economical, since a normal uranium fuel rod is cheaper by half. He stresses, however, that "the elimination of plutonium is a matter of the greatest political importance."

The producers of fuel elements cannot enjoy unbounded jubilation about the end of the arms race, however. On account of the enormous quantities of highly enriched uranium, which was used along with plutonium to fill the warheads, the fuel market is threatening to collapse. The uranium of nuclear weapons is about 90 percent enriched with the fissionable isotope 235. If it were to be "thinned" with the natural uranium-238 to an enrichment level of 3 to 4 percent, which would be suitable for reactors, all of the nuclear power plants in the world would be supplied with fuel for about two and a half years—a nightmare for the uranium dealers. To this can be added the enormous production capacities for enriched uranium which were created in the Eastern bloc for strategic reasons.

FACTORY AUTOMATION, ROBOTICS

MBB Develops Image Processing System for Precision Machining

92WS0631D Munich NEW-TECH NEWS in English No 1, 1992 pp 17-19

[Excerpt] [Passage omitted] SCOUT, the seam-follower sensor, was developed by MBB to be a member in the product family of "beam-delivery and beam-positioning systems for high-power lasers."

SCOUT is an image-processing system for three-dimensional seam following and consists of a sensor

system and an evaluation unit. An illumination apparatus and an industrial camera are integrated in the sensor system, which is mounted directly on the robot's hand. SCOUT illuminates the seam with light bars, and the resultant "pattern" is recorded at an angle by the integrated camera. When the machined material is a plane surface, the light bars take on the form of straight bars. However, if the field of view registers a difference in height, for instance a sheet cut, a "jump" can be seen in the bar.

The evaluation unit connected to the sensor system analyzes this jump and determines the distance and the lateral position of the seam in relation to the robot's hand. The core of the evaluation unit is the image-processing hardware. It has been specially tailored for this application and contains, besides the processor for monitoring and communication, signal processors in a parallel architecture. Various user-specific circuits ensure rapid data interchange within the system as well as smooth data takeover from the camera interface.

The seam data is supplied to the robot control via a parallel or high-speed serial interface. SCOUT is characterized particularly by its seam-following speed. Conventional systems use a laser beam to scan the surface and determine the distance on the basis of numerous single measuring points. This is a simple method, but an extremely slow one, as all the measurements are conducted sequentially.

In comparison, SCOUT processes a new frame every 20 milliseconds, whereby several points on the seam are determined from each frame. Thanks to the high computing capacity, it is possible to achieve welding velocities of up to 20 m/min.

SCOUT	
Accuracy in depth	0.1 mm
Lateral accuracy	0.1 mm
Accuracy of perpendicular	0.2°
Sensor weight	1.2 kg
Dimensions	150x90x60 mm
Illumination	class-1 laser
Frame update rate	20 ms

In addition to the position of the seam, which is determined absolutely accurately to within 0.1 mm in all three dimensions, the perpendicular on the workpiece and the seam direction are also calculated. Total seam following is the result.

To stay with the example of the auto industry, one possible application for SCOUT could be welding carbody folds, for instance on a trunk lid. The lid consists of an outer skin and an inner structure. Both sheet parts are deep-drawn and placed inside one another. The outer skin is then folded. Normally, a sealing strip is placed in this fold and spot-welded. However, in time cracks usually form in the sealing material and humidity may penetrate. Whoever has driven an older car knows that corrosion starts at these very folds (trunk lid, doors), and the result is rusty sheet metal.

This problem can be solved by a laser-welded seam. The parts are sealed perfectly; moreover, the strength of the bond is increased thanks to the homogeneous load distribution along the weld. The remaining obstacle is how to prepare the sheet cuts. A trunk lid made in this manner has seam-position tolerances of a few millimeters. This means that every seam would have to be programmed individually. This is of course impossible, as series production calls for a cycle time of one minute per part. SCOUT was developed for this very type of application.

To start off with, the seam parameters are supplied to SCOUT via a terminal. The shape of the seam is then represented on a graphic display. This is how SCOUT makes it possible to store innumerable seam geometries. On starting the machining process, the robot's hand is made to set down at a defined point. SCOUT identifies the seam and supplies its exact position to the robot control, which then guides the robot along the seam. To orientate itself, SCOUT also scans the robot's position. This closes the control loop, and consequently the variations in sheet cuts which are caused during production are offset.

Further problems inherent in laser machining are the increasing size of the facilities and the growing number of axes that are required. This complexity calls for ever greater precision. Likewise, the focus intensity varies, due to the possibility of changing the beam path length with large gantries. This downgrades both machining rate and weld quality.

Performance is enhanced substantially thanks to FOCON, an active beam-delivery system. FOCON consists of an adaptive mirror, a sensor and a processor-driven control unit.

FOCON	
Free aperture	55 mm
Optics	water-cooled mirror optics, focusing mirror optics (optional)
Nominal laser power	between 100 W and 25 kW
Variation of laser power	10% to 100% nominal power
Mode of operation	continuous-wave pulse (optional)
Accuracy of control	beam tilt relative to mechanical axes $\leq$ 50 µrad, focal length error +/- 0.1 mm
Control range	tilt +/- 1.5 mrad, focal length +/- 3 mm (at f = 150 mm)
Frequency range	30-Hz tilt, 1-Hz focal length

The adaptive mirror is placed in the beam path as a bending mirror close to the laser source. It can be tilted in all directions perpendicularly to the beam axis in

order to guide the laser beam. In addition, the mirror surface is spherically deformable.

The sensor is integrated into the final focusing optics. It outcouples a minute amount of the laser beam intensity by means of a hole grating mirror and simultaneously measures its angular deviation and divergence. The control unit accepts the sensor signals and drives the adaptive mirror.

This control loop serves to keep the focus position constant at all settings of the beam-delivery system. FOCON is a valuable aid in basic system adjustment, too. In series production, the control unit can be coupled with the overall system control. This makes it possible for the system to be switched off as soon as the laser beam leaves a tolerance zone, which has been defined in terms of laser power and focus position.

The third product from the beam-delivery family is the LASS laser-switching system, which enables laser beams from one or several CO_2 laser sources to be variably assigned to different machining stations. Consequently, LASS ensures that facilities are utilized to full capacity and redundancy increased.

LASS

Free aperture	70 mm
Optics	coated and cooled copper mirrors
Expansion ratio	1.2 to 2.0
Angular stability	$\leq$ 10 µrad
Switching time	2 s

This product family has aroused keen interest on the part of industry at trade fairs. SCOUT, FOCON and LASS are expected to be put on the market in early 1992.

France's Sintertech Automates Production Process

92WS0664A Paris INDUSTRIES ET TECHNIQUES in French 22 May 92 pp 46-47

[Article by Christian Guyard: "Sintertech Automates Sintering"; first paragraph is INDUSTRIES ET TECHNIQUES lead]

[Text] By reorganizing its manufacturing around automated production lines and manufacturing cells, the subsidiary of Pechiney and Usinor Sacilor is showing the major principals of the European automobile industry that it is a leader in its business.

"There are some 100 major variants of engine/transmission systems among the European auto makers. How many will there by in 10 years? Will there be product groupings around joint projects?" Jacques Pinettes, president and CEO of Sintertech, would very much like to know. Unfortunately, no one has an answer for him, either to these questions or to his questions about the Japanese auto makers' strategy in Europe. When you cannot know the specificities of the market, the only solution is to work on your company's performance and to do everything possible to make it the first in its sector and, above all, keep it there. This is why a vast production reorganization program was begun at the end of 1990 and will continue until 1993.

Created in July 1991 by the merger of Alliages Frittes Metafram and Oloron Frittage, Sintertech, a subsidiary of Pechiney and Usinor Sacilor, is the leading French sinterer and the only company in the country that produces mechanical parts by steel sintering. The technique consists of making parts from a metallic powder that is formed by pressing and then cooking (sintering) it. Eighty percent of its production is for the automobile industry. This proportion should not vary appreciably since sintering is mostly profitable only on large lots such as the automobile industry alone can offer. Thus Sintertech's goal is to be the European leader. Auto makers have definitely changed their approach. "We are no longer just suppliers of pinion gears; we are full partners in the development of automobile subsystems," Jacques Pinettes says. "By 1993-1994, we will be delivering finished synchronizer components, that is, 10 to 12 assembled parts ready for mounting in the transmission." In the longer run, everything relating to distribution in the engine may be involved. The number of parts produced by sintering may also increase with the advent of active suspensions, adjustable shock absorbers, and new designs for oil pumps, automatic transmissions, and power-assisted steering. All of these changes are aimed at increasing vehicle reliability and comfort. "We are in a good position in France," Jacques Pinettes says. "On the one hand, the PSA [Peugeot Societe Anonyme] group, Europe's biggest consumer of sintered parts, is pushing product development. On the other, Renault, which still uses few sintered parts, probably has the greatest growth potential."

"Auto maker requirements and technical developments in our area have led us to take an in-depth look at how we produce," according to Paul Cariat, general manager. "At Oloron (one of Sintertech's three sites), we had automated one production line. At Alliages Frittes, a similar project was being studied. When Sintertech was created, the analysis continued, the guiding principle being the homogenization of the machine base and process and part forming machines." It was a true "production streamlining" approach which resulted in an investment plan calling for almost 50 million French francs [Fr] to reorganize production (1990-1993). The plan had two major axes: mass production on automated production lines and smaller scale production in manufacturing cells.

The Veurey site, which produces parts with an average weight of 130 grams, already has a fully automated production line. From powder to final packaging, the production cycle for a part is two hours. It used to be three weeks! There is no manual intervention. Everything—the handling of the workpieces, the weighing of the units after pressing, the packaging—is automated. This supposes a major cultural change. "On this line,"

Paul Cariat says, "operators no longer specialize in one specific area: pressing, calibrating, finishing, or packaging. They form a team that is in charge of production." In addition, one operation follows the other. It used to be that the workpieces were stockpiled moved [as published] between each phase. Handling of unsintered workpieces, which are by nature fragile, resulted in delamination defects. The operator's work has become more rewarding, according to Mr. Porta, a worker on this line who has experienced both ways of working. "The automated line is more exacting, but it is also 'easier' on the mind. Production is handled by a team, and it is the team that deals with any problems." The team also provides its own original solutions, such as modifying a material-handling car to do press toolchanges. "The tooling is preset before mounting and the toolchange takes two hours instead of a day, as in the past," Mr. Porta says. The operators also do the dimensional inspection. They input the data into the computer at a shop terminal. They have access to statistical production data. This organization has tremendously increased productivity while at the same time improving quality and reducing tedious tasks. However, it requires real employee involvement as well as considerable training. At the Veurey site, 6 percent of wages have been devoted to training (over three years).

The manufacturing cell approach is used at Pont de Claix (three cells) and Oloron (two cells). From the methods standpoint, this means that parts must be grouped by families. At Pont de Claix, each of the three cells centers around one or more presses with closing pressures suited to a range of homogeneous parts. It has a control area and a rest area. Production is done in lots of 40,000 to 200,000 parts per month. Each cell has three workers to a station but no station overseer or foreman. A shop foreman is responsible for the unit. "The problem is in putting together homogeneous groups whose members get on well," Paul Cariat says. "To get things started, we asked for volunteers. But you have to be very alert and make people feel secure in their work"—because, there too, the responsibilities are greater. Every operator is versatile and insures first-level machine maintenance. The cell must also handle its own toolchanges and pool of tools. The gains in productivity are achieved in the production changes.

[Box, p 46]

7,900 Metric Tons of Sintered Parts a Year

Sintertech. The name is "transparent" to most foreigners, since, where we say *"fritter," English-, German-, and Spanish-speakers say "sinter." A subsidiary of Pechiney (66 percent) and Usinor Sacilor (34 percent), the firm has annual revenues of around Fr480 million and a staff of a little more than 900 people. Eighty-eight percent of its business is with the automobile industry. The weapons, mechanical, and electromechanical industries absorb the rest of its production.*

Steel sintering activities are divided among three sites: Veurey and Pont de Claix, near Grenoble, and Oloron. Veurey employs 300 people and specializes in mechanical engine parts, notched wheels, and oil pumps. The site produces around 3,800 metric tons. Pont de Claix (260 people) manufactures 2,500 metric tons of parts for transmissions, hubs, and synchronizer rings. At Oloron, 145 people produce over 1,600 metric tons of various parts. Pont de Claix houses the research department, where the tools are designed, and the development center. Development represents more than 5 percent of revenues and is the key to the markets which the firm is seeking to steal from machining.

Today, Sintertech is second in Europe in terms of sales value (10 percent of the market), behind Krebsoge (13 percent of the market) and ahead of the British GKN. In terms of volume, the French firm is first, ahead of GKN (Europe's biggest bearing manufacturer) but ahead of Krebsoge [as published]. They are trailed by two German firms and a Spanish company of significant size, followed by several small national manufacturers.

[Table, p 47]

Evolution of Sintertech Production Methods

In January 1991, 3 percent of total part volume was produced on automated production lines, 3.5 percent in manufacturing cells, and 93.50 percent by traditional methods. In December 1991, 15 percent was produced on automated production lines, 10 percent in manufacturing cells, and 75 percent by traditional methods. By the end of 1992, 60 percent will be produced on automated production lines, 25 percent in manufacturing cells, and 15 percent by traditional methods. Also by the end of 1992, automated production line work will account for 60 percent of workers; manufacturing cell work, for 25 percent, and traditional production, for the remaining 15 percent.

Evolution of Robotics in Switzerland's Staeubli Presented

92WS0664B Paris INDUSTRIES ET TECHNIQUES in French 22 May 92 pp 65-66

[Article by Philippe Grange: "Staeubli, or in Praise of Perseverance"; first paragraph is INDUSTRIES ET TECHNIQUES lead]

[Text] With its new line of robots, Staeubli, the Swiss textile machine maker, hopes to profit from 10 years' work to establish itself in robotics.

"If we had it to do over, we probably would not," they say at Staeubli, the 12th largest process robot manufacturer in the world. For 10 years, Switzerland's leading loom programmer "has sweat blood and tears" to stay in a diversification activity that has not entirely lived up to its promise. At Hannover, persevering despite the lackluster market, it has nevertheless just fired the last stage

of the "Staeubli rocket": a new line of robots. The stakes are high. If it loses, there may be no next game!

Staeubli is first and foremost a family company, principally managed by the heirs of the founders. "Like the Japanese, we emphasize the long term, and we reinvest our profits. For us, this company is not a cash cow," says Jean-Luc Burquier, head of the robotics division. This is a significant factor, and a determining one, since the idea of conquering robotics would not have lasted had it not been for the steadfastness of a few owner-managers.

Enticed during the glory years of robotics by fabulous market forecasts (growth rates of 25 percent were often predicted but rarely fulfilled), in the early 1980s the management of the company thought that this activity would give it a solid third pillar that would balance its two other activities, which are subject to large amplitude (1:3) cycles: textile machinery and industrial connectors. Robotics fit in well with Staeubli's perception of itself as a precision mechanics firm, and in mid-1981 it was officially chosen as a diversification activity.

Brilliant for its simplicity and pragmatism, the battle plan was supposed to unfold in three phases. First, Staeubli would learn the robotics business and find a robot to distribute as quickly as possible. After three years, it would begin manufacturing robots under license in order to become more familiar with the engineering. Within six years, it would be designing and producing its own products. Having established these objectives, "we did not define the resources or even estimate what it might cost. The sole, driving idea was eventually to make 1 to 1.5 billion French francs [Fr] in robotics," Jean-Luc Burquier says.

Bidding successfully against Matra and an Alsthom subsidiary, Staeubli obtained the contract to import the U.S. Unimation's Puma robots, which until then had been distributed by Stockvis. Unimation, the "historic" leader, and its symbolic head, Joe Engelberger (the father of robotics), demonstrated its determination to help establish its robots in the French market. Staeubli Robotique officially debuted in May 1982 at the first Salon Productique [Computer-Integrated Manufacturing Show]. From the marketing of palletized machines (without added value) to the turnkey delivery of cells, Staeubli learned the business fast, going from the four robots a year sold by its predecessor to almost 100 installations six years later.

Ignoring the automobile industry and its reigning application, point welding, Staeubli looked for sales in sectors with applications requiring the manipulation of loads of 5 to 20 kg by five- or six-axis robots (arc welding, finishing, machine loading). This technical approach was original in comparison with that of its competitors, which reasoned more by industry or market. It also led the company into varied, often unique, and at times very complex applications. "In 1987, we still did not have our heads above water. Our sales revenue cost us a lot in those days because of engineering- and peri-robotics-intensive applications. We really did "buy" our way into the market," Jean-Luc Burquier now acknowledges.

While the first objective was reached in five years, the second—to build a robot under license—was never achieved. The decision had been made to build the Unimation 2000, a big handling, palletizing and loading/unloading machine. In mid-1983, the giant Westinghouse bought out Unimation, and the following year, as provided for under an antecedent contract, Staeubli sent a team of six people to Connecticut to learn all about this robot. The engineers quickly realized that the engineering was obsolete. Staeubli purely and simply decided not to build it!

Already at that time, engineers at the Faverges plant (Haute-Savoie) were beginning to work on designing their own machine: a four-axis robot called the RS that was designed to palletize, handle, and manipulate 40 kg loads and priced at around Fr450,000. Five people worked for three and one-half years to build it. They were assisted on complex calculations by mathematicians from the textile branch's research department and by the group's methods/quality department when it came to production.

Launched in 1987 (according to the schedule established six years earlier), the first Staeubli robot required an investment of approximately Fr20 million. The RS family of robots quickly filled out with the addition of a six-axis, 30 kg capacity robot and a five-axis, 5 kg capacity robot the next year.

The 1987 RS sales forecast of 250 units over the next five years, for a total of 500 robots by 1992, would prove a cruel disappointment. First, the agribusiness palletization market, which appeared promising in the mid-1980s, turned out to have been only a flash in the pan. Next, it became apparent that the technological choices made for these robots (direct current motors, incremental encoders, VAL computers with old-style microprocessors) were being swept aside by the tide of history (alternating current brushless motors, absolute encoders, powerful computers, and user-friendly software).

Lastly, the targeted price proved unattainable. In the end, the first RS came out at almost Fr600,000 instead of the original, theoretical price of Fr450,000. "We very quickly realized that the objective of 500 robots in 1992 was not realistic," Jean-Luc Burquier says. "Now, knowing how capricious this market can be, we prefer not to say anything anymore. We take what comes." According to the group's latest estimates, Staeubli will sell a maximum of 300 robots in 1992. While not very many in view of its objectives, it is a lot in view of the economy.

The real turning point came in 1988 when Staeubli sought to extend its import agreement on Unimation/Westinghouse Puma robots to the rest of the European Community. "Are you that interested in robotics? We

are prepared to sell you the entire electric robotics division," the U.S. firm told it. The opportunity was too good to pass up. By the end of 1988, for a price that was "very decidedly less than a year's revenues," Staeubli had acquired a prestige label, a manufacturing plant in Telford (United Kingdom), a sales and part distribution center in Frankfurt, the VAL programming language source code, and the robot electrical engineering (the hydraulic robots having been sold to the American firm PRAB).

From then on, things were simple. In the United States, Unimation's strong point was that it had 40 percent of the market in "clean" robots for use in electronic industry clean rooms. In Europe, Staeubli was the principal vendor of Puma robots (up to 30 percent of the total in good years). It now had an installed base on the order of 2,000-3,000 working robots!

Even so, the French engineers realized that these machines—the first of which had come out 15 years earlier—would have to be modernized. "When we were analyzing the value, it became evident that Westinghouse had not paid a lot of attention to Puma and that there was no development strategy. Only the VAL language, Unimation's best idea, comes out looking good," they say at Faverges.

In 1989, Staeubli began research on the future replacement for the Pumas, dubbed RX. This research and development effort would cost another almost Fr15 million. In France, through ANVAR [National Agency for the Exploitation of Research], the General Directorate of Industry provided around Fr6 million in subsidies. In return or not, it was decided to relocate all robotics activities to France. The British mechanical manufacturing plant has just been closed, as has the Swiss plant that assembles the Unival controller. R&D, manufacturing, marketing, and sales will all be grouped together near Annecy, forming a single robotics headquarters.

Hannover 1992: The first RX model, replacing the Puma 560, is unveiled. "This is the final stage of the Staeubli robotics rocket, and we are going to do everything possible to get it successfully into orbit. You can write that," Jean-Luc Burquier said. And so we have.

[Box, p 65]

The Most French of the Swiss Groups

The Staeubli company, which celebrates its centennial this year, has a staff of 2,000 and revenues of Fr2 billion from three business areas: textile machinery (Fr1.5 billion), industrial connectors (Fr350 million), and robotics (Fr150 million).

Held by its Swiss founders—the third generation of Staeublis are currently at the helm—the firm has always been intimately involved in the history of the Rhone-Alpes and Haute-Savoie region. It has a 350-person production facility near Lyon, in Chassieux. The group's world headquarters for robotics, which employs 860 people, is located in Faverges, near Annecy. The size of its French sales revenues—over Fr700 million—further confirms this group's symbiotic relationship with France.

[Box, p 66]

The RX Robot: Staeubli's All-or-Nothing Bet

The primary objective of Staeubli's very technologically and visually up-to-date RX robots is to replace the three aging Pumas (the 260, the 560, and the 760), restore the confidence of Puma users, and provide an alternative to German and Japanese products. "With the announcement of the new models, which will not even be marketed until 1993, some of our old customers are contacting us again," the company says.

At the market price (Fr320,000 for the 1990 model with 6 kg capacity and six degrees of freedom) and with the technological innovations (thanks to the Staeubli engineers' know-how in reducers and bearings), plus a new control system, a rapid combined speed (8.4 m/s), and three models, these RXs should make it possible to zero in on the initial objective: 1,000 robots a year by the end of the decade. Now distributed in the United States by almost 20 companies through its new Pittsburgh affiliate, Staeubli is aiming for 3 percent of the U.S. market. In Europe, it has set its sight on 5 percent of the market. Rather than resorting to a price war, its European strategy is to target technological markets (deburring, assembly, etc.) or commercial niches (the electronics industry in particular) and to offer top-of-the-line machines and service (but not integration).

[Graph, p 66]

Staeubli Sales

Staeubli sold 25 Unimation Puma robots in 1983. In 1987, it sold 26 Puma robots and 20 of its own RS Robots for a total of 65. In 1990, it sold 290 Puma robots and 70 RS robots for a total of 360. In 1991, it sold 210 Puma robots and 59 RS robots for a total of 269. In 1992, it is expected to sell 200 Puma robots, 70 RS robots, and five Staeubli RX robots for a total of 275. In 1993, it hopes to sell 190 Puma robots, 100 RS robots, and 50 RX robots for a total of 340.

Deficiencies of French Robotics Industry Analyzed

92WS0667B Paris INDUSTRIES ET TECHNIQUES in French 5 Jun 92 pp 52-55

[Article by Philippe Grange and Mirel Scherer: "French Manufacturers Far From Reaching Critical Size; French Robotics' Missed Opportunities"—first paragraph is INDUSTRIES ET TECHNIQUES introduction]

[Text] France was unable to develop a competitive robotics industry during the eighties. It lagged behind Sweden, Germany, and Italy.

Should we blame the weakness of French robotics on the supply or on the demand? This is somewhat like asking who came first, the chicken or the egg. With the difference that in this case—contrary to the rosy predictions of economists—the egg was not a golden egg!

With demand down in 1991 (680 million French francs [Fr] compared with 780 million in 1990), French suppliers of industrial robots, i.e. the dozen or so that still remain, have just gone through 10 lean years. Prospects are not much brighter: the price war is starting again, pressure from foreign suppliers is getting stronger, and no French manufacturer appears in a position to take advantage of the Europe of 1993—unless it agrees to take a back seat in a conglomerate.

Their fate was probably decided 15 years ago, when strategic errors compounded whatever developments where taking place then. For instance, the first robots built for Renault were hydraulic robots because the only task for which the French manufacturer recognized an advantage to robots (spot welding the R16 wheel wells) involved handling a grip weighing 25 to 30 kg and working at the rate of one weld spot per second to be competitive with workers. At the time, electric robots could not meet these requirements. But, when more powerful electric motors became available, was it the right thing for Acma Cribier (now Renault Automation) to stay with hydraulic robots?

Another source of errors: sophistication. The first French robot experts had soon "intellectualized" the subject. That is a characteristic fault of the French. They did everything to differentiate their machines from simple "non-intelligent" handling devices. But history has shown—especially in Japan—that the simplest of simple machines will prepare users to use sophisticated robots, with no trauma, and with a reassuring technological continuity.

We could also blame the erring ways of our large manufacturers. In hindsight, we see that robotics world leaders are all electric/electronic companies (ABB [Asea-Brown Boveri], Fanuc, Mitsubishi, Yaskawa, Hitachi, etc.). In France, large manufacturers which, for a time, viewed robotics as a strategic field, soon lost their pugnacity; we mean CGE [General Electricity Company], MATRA [Mechanics, Aviation, and Traction Company], Thomson, Schneider, Alcatel-HBS, Citroen, and the SNIAS [National Industrial Aerospace Company (Aerospatiale)].

Leading French Manufacturers

1991 Manufacturers	Sales (million francs)	Installed Base	Personnel
Renault Automation	380	3,035	160
ABB Robotics	182	1,750	150
GM Fanuc	115	350	35
Staubli	40	400	50
Reis	18	70	5

With an installed base that increased from 600 to 10,000 units in 10 years, France, with a demand for 1,000 robots per year, is too small a market to guarantee its suppliers' profitability. The figures show this clearly (see box on robot development): to be credible, a manufacturer must offer at least 10 models. To amortize development costs (10-25 percent of sales), annual robot sales must exceed 1,000 units. The best French scores for 1991 hover around 300 units (Renault Automation, Staubli).

Key Figures to Profitability

	Handling Device	Controller
Cost of R&D	Fr20 million	Fr40 million
Sales to be generated if R&D is to be 10 percent of sales	Fr200 million	Fr400 million
Unit selling price	Fr300,000	Fr200,000
Number of units to sell to achieve profitability	700	2,000
Service life	6-7 years	4-5 years

To remain competitive a robot manufacturer must sell over 1,000 units per year.

Nevertheless, this analysis must be qualified: "It is because the largest market, the automobile market, is supplied by a car manufacturer subsidiary—Renault Automation—that manufacturers of general-purpose robots were unable to develop their sales in France," people at Staubli estimate. And it is precisely this monopoly that foreign companies (ABB, GM-Fanuc, Kuka, etc.) successfully tackled. The stakes were well worth the effort; whoever holds the automobile and automotive market holds over 50 percent of the French market. "French car manufacturers subject us to long and costly tests to validate our solutions," Gerard Binoche of the Kremlin Company told us. "Come ordering time, we have an unpleasant surprise: we find that they have chosen a foreign robot manufacturer which can afford to cut prices. This is what happened to us at the Peugeot plant in Sochaux; after carrying out long studies with us, they chose to install GM-Fanuc painting robots. Certainly, such an approach will eventually ruin the French robotics industry. Our only salvation, therefore, is to conclude a partnership with a Japanese company, Kobe in our case."

In this context of aggressiveness, a price war was unavoidable: eventually, it will doom modest-sized manufacturers of general-purpose robots. Its effects are further increased by the natural trend toward lower robot prices, due to improved quality and longer MTBFs (mean times between failures); 12 years ago, a client would pay for his robot once when he first purchased it, and several times over in maintenance costs.

An INDUSTRIES ET TECHNIQUES inquiry showed that average prices—which went down by nearly 4 percent in current francs for any given model between 1982 and 1987—have dropped by 25-30 percent during the past five years! In 10 years, the manufacturers' sales breakdown has considerably changed (see table below).

This statement, however, must be qualified: although "plain robot" prices decreased during the early eighties, clients did not pay less for all that. Actually, suppliers were making up for lower prices by selling robot peripherals (parts feeding systems, special tools, vision systems, etc.). On the other hand, during the late eighties, lower prices affected essentially "robot-based solutions" as a whole. Robot manufacturers then had to cut prices for engineering (their knowhow), training, and even for the development of application software. The situation became untenable and further accelerated the decline of the French offer to nearby or niche clients; this benefitted supranational groups which can amortize costly non-material investments by selling the same application to several clients.

Variations of Robotics Sales Breakdown

	1987	1992
Plain robots	60 percent	30 percent
Robot-based systems	25 percent	50 percent
Customer service, training, overhauling	15 percent	20 percent

From now on, the price war also covers engineering and software; the situation is untenable!

There is another way to explain the failure of French robotics: it has to do with the failure of researchers and manufacturers to come together. If they could not establish themselves on the basis of a "product" strategy, our manufacturers could at least have been innovative. Our laboratories—in particular the CEA [Atomic Energy Commission]—have developed interesting prototypes, sometimes with a comfortable lead: a laser robot whose beam went through an arm structure; a laser-scan welded-joint monitoring system; a direct drive robot; programming languages (including the "LM" language developed by ITMI [Intelligent Machine Industry and Technology], from which our competitors of today derived much of their inspiration); and even a hybrid force-position control, available in France for many years and that the Japanese are beginning to add to their robots. "The problem of French robotics is that the budgets manufacturers provide are too tight," Guy Micoulet of ABB Robotics claimed. "Contrary to industrial data processing, where it is an accepted practice to develop a preliminary master diagram for the application, the parsimony of robotics investments does not allow for testing before purchasing a robot, except in a few cases. This big leap into the unknown accounts for one-half of all French failures in this field. Our work with Renault, in Sandouville and in Flins, shows that the situation will change when the robot suppliers become the users' true partners."

If you ask robot manufacturers who will remain in the race by the year 2000, their answers always include two or three Japanese in addition to ABB and a second hypothetical European supplier (American suppliers vanish, as General Motors Fanuc robots, except for one particular model, will be manufactured by Fanuc in Japan).

To exist, this European manufacturer will have to go well above the "1000 robots mark." Barring a last-minute partnership among leading national manufacturers (the German Kuka, the Italian Comau, the French Renault Automation), we do not see how it could emerge.

[Box, p 53]

Exporobot: Falling Prices

Precise, reliable, easy to use, and especially inexpensive. Such will probably be the robot of the nineties, heralded by the equipment shown at the Exporobot Show which just took place at Le Bourget. All manufacturers are striving for this ideal. Ahead of the pack, because it marketed its IR-761 (a 125-kg machine) already in 1991, Kuka complements its line with an all-purpose robot, the IR-364, which can handle loads of up to 10 kg. Its strong point is a repeatability precision below q0.1 mm, guaranteed even at maximum speed and load. For its part, Renault Automation offers the Acma XR-700. Like its predecessor, the X-88, it is designed for welding, handling, and car assembly applications. The six-axis robot with multiple articulations was designed based on value analysis. Maintenance characteristics, for instance the time required to change a defective component, were taken into account. The result is increased availability, a reduced number of components, and a price—Fr500,000—30 percent below that of the X-88. Other performance characteristics, e.g. improved speed and precision, reflect this determination to meet users' requirements as closely as possible.

These remarks are just as valid for ABB's IRB-1500. This six-axis robot is designed to handle 5-kg loads in widely different applications. For instance, the wrist, designed as an extension of the arm, makes for easy

positioning and provides access to the most cramped corners. Other manufacturers are doing just as well.

Staubli's RX-90 improves by 30-50 percent the capabilities of the Puma 560 which it replaces. It does so for Fr350,000, i.e. 20 percent less. Using the same approach, GM-Fanuc emphasizes control and introduces a rack that can pilot two robots simultaneously. The German Reis's concerns are small to mid-size industries which face a shortage of skilled welders, and the welding of small series parts that usually do not warrant investing in automated devices. Its robot-based welding cell is a turnkey system which sells for Fr500,000 and can thus be amortized in 18 months. Let us hope that all these efforts will revive users' interest, for although much is written about robots, there are still far too few of them in workshops.

[Box, p 54]

Industrial Robots or Service Robots?

Does the future of robots lie with industrial or with "service" equipment? Gathered by our colleague AXES ROBOTIQUES to celebrate the 30th birthday of robotics, the world's greatest experts are split over this question. The father of the first robot, the American Joe Engelberger believes that automation techniques should be extended to many potential applications that are emerging outside factories. "That will mean a revival of robotics," he explained, "because robots will have to become mobile, sensitive, and intelligent." Robots as surgeons, pharmacists, or nurses, robots as cleaners, fast-food waiters, farm or space "workers," gas-station attendants, soldiers, etc.: their ambitions are many. They can also perform dangerous tasks (mine removal, underwater operations, nuclear plant maintenance, drilling, etc.) or help handicapped and old people. "Serious research and development program are in progress in each of these fields, and some products have already been tentatively introduced," Joe Engelberger went on. Just a few months ago, for instance, the American company Transition Research Corporation (TRC) installed a self-contained mobile robot at a Danbury hospital, in California. The "HelpMate" replaces the staff supposed to bring meal trays, laboratory samples, or medicines to the doctors or to the patients. "For the time being, the United States have the technical leadership, but Japanese manufacturers may well catch up with them, as they did with industrial robotics."

The boss of Yaskawa, Koh Kikuchi can only agree. "Thanks to these new field applications, the Japanese robotics market will reach $10 billion during the next century," he explained. "We are developing and testing new technical solutions at our Japanese research center, the Motoman Center."

Although he does not dispute the prospects of these new robots, the president of ABB Robotics, Stelio Demark, believes that industrial robots still have a long way to go. "More affordable prices and enhanced performances will attract new users," he believes. "Hard work, such as welding and painting, will be fully automated in the future. And two fields of application will be increasingly considered: industrial handling and industrial processes." According to his calculations, robotics still has a huge industrial potential. "It will take at least one million robots to replace 2 percent of the world's manual workers," he explained. Fiction... or truth? Users will decide.

[Box, pp 54-55]

Market: No Miracle in the East

Robot manufacturers who thought they would find a new El Dorado in former East Bloc countries are in for a disappointment. The new automobile factory that General Motors just built in Hungary (representing a total investment of Fr1.36 billion and a projected staff of 650 people) confirms this prognostic through its technological choices. Located a few hundred meters from the Austrian border, it is the assembly plant for the Opel Astra, the first unit of which rolled out of the assembly line last 13 March. The production systems adopted by the experts of the Opel research and development center, in Ruesselsheim, are fully manual. Even body welding, an operation performed by robots in EEC factories, is done by men here. These are genuine "hand-made" cars, to be shipped to future Hungarian (and other European) buyers. The reasons for this pragmatic choice are the small number of vehicles assembled every year (15,000), the country's financial situation, and a cheap labor force. Average Hungarian wages barely exceed Fr1,500. And although the wages of Hungarian workers at the Saint-Gothard factory are twice the wages paid elsewhere in Hungary, they are still four to five times lower than those of their counterparts in the EEC. As for car prices, in Hungary they will be as high as Fr77,000. However, the absence of automation did not prevent the installation of an organization that has nothing to envy Japanese factories. Just-in-time (inventories do not exceed four working hours), performance indicators, customized aids to manufacturing, state-of-the-art quality-control equipment (Stiefelmayer three-dimensional measuring machines), specialized training for workers and technicians (who can do several jobs) at the Opel factory in Portugal, the one whose characteristics are most like those of the Hungarian factory; nothing, therefore, was left to chance. This approach, however, is not systematic. The production of 200,000 engines per year—for the European factories that manufacture the Astra—will take place in a nearby workshop, on automated production lines (currently being installed).

French Industry Using Off-Line Robot Programming

92WS0704C Paris L'USINE NOUVELLE in French 2 Jul 92 pp 50, 51

[Article by Olivier Lauvige: "Off-Line Programming Eliminates the Learning Process; There Is No Longer

Any Need for Robot Hand-Holding"—first paragraph is L'USINE NOUVELLE introduction]

[Text] A new technique makes it possible to use a digital model to program, simulate, display, and optimize the motions of a robot. But watch out for inaccurate representations.

Off-line programming software removes the need for long and boring sessions during which the operator would manually teach a robot how to do its work.

Actually, the traditional on-site programming technique has many drawbacks. First, it requires manufacturing an initial part, a prerequisite to programming the handling device. During this learning stage, the device is unable to work. Finally, this method is not supported by a digitized definition of the part, and it breaks the CAD/CAM [computer-aided design and manufacturing] chain of any computerized production.

This technique is now a thing of the past. Off-line programming software will model the components of a robot cell, compute the paths of its handling devices and simulate their motions. "Beware not to confuse these systems with CAD software programs," Gheorghe Moga, the Tecnomatix sales manager in Palaiseau and a specialist of off-line programming, nevertheless warned us. The former are used to model a static system along its three dimensions, whereas the latter cause it to move and make it possible to study its motions in a dynamic way. Thus, based on robot kinematic data (travel lengths, stops, acceleration, velocity, etc.), they can pilot the various components so that the end of the robot arm moves along a well-defined path. It then becomes possible to generate programs for any robot on-screen and off-site.

The Saint-Eloi plant of Aerospatiale, in Toulouse, uses Robcad, a Tecnomatix software program, to cut sheet-metal along three dimensions, using a six-axis laser machine. The software computes directly the route followed by the nozzle, based on characteristic cutting points. Simulation is then used to display these motions, optimize the paths, and check on-screen that the program is unfolding properly.

Industrialization Lead Times

Sediscad, the CAD/CAM subsidiary of Renault Automation (sales of 50 million French francs [Fr], staff of 50) also offers an automatic module to compute paths in crowded environments; it can take into account the environment in which the robot will work. And it can define on-screen the path of any handling device. The system is used in particular to pilot intervention robots in the steam generators of nuclear power plants.

Off-line programming offers many other benefits. First, it shortens industrialization lead times for new products. In fact, it is now possible to program the cutting robot as soon as the CAD definition of a part is available. In addition, off-line programming eliminates the need to manufacture a reference part. "Designers think ahead and therefore move the industrial risk upstream in the production chain," Gheorghe Moga added. "If a product proves unfeasible, they will notice before the first unit is manufactured."

This technique also reduces tooling lead times, as it makes it possible to check on-screen any chance that tools might collide with the handling device. It also preserves the continuity of the digitized chain. If the part is altered by the engineering department, the cutting program can be automatically updated. Finally, the robot does not have to stop working to be programmed.

However, off-line programming has its limitations. It works only with digital models that are 100 percent accurate and processes that are fully mastered. This is not always the case in the industry. Robots are not all extremely precise. And the motions of their digitized models do not always reflect their actual motions.

At Aerospatiale, for instance, on-site corrections are sometimes required. And off-line programming is not yet applicable to component welding. In fact, welding requires too much precision in parts positioning and welding-torch motion.

On the other hand, three-dimensional measuring machines offer the required precision. Also, as they are extremely expensive (over Fr1 million), they cannot be allowed to remain unproductive during learning stages. Therefore, they are a choice application field for off-line programming. Several software developers have thus specialized in this niche. One of them is the U.S. company Valysis, which equips the metrology units for the Peugeot plants in Sochaux and Charleville-Mezieres. Eventually, all of Peugeot's measuring machines should be connected to the system, which reduces their programming time by 30 to 40 percent.

For its part, Sediscad also offers an off-line programming module for measuring machines; it is called Uni-Mesure. Fully integrated into the Euclid-Is CAD/CAM software of Matra Datavision, it automatically generates the machine-piloting program according to the neutral DMIS format (Dimensional Measuring Interface Specification). However, the metrologist requires a few days of training on the system. But the procedure reduces programming times by a factor of 10, people at Sediscad pointed out. This sector now seems more buoyant than that of robot programming. It has a growth rate of 5-10 percent. And of the 2,000 measuring machines operated in France, 95 percent still spend much of their time in learning sessions.

Germany: Fraunhofer Institute for Factory Automation Described

92WS0715C Berlin FERTIGUNGSTECHNIK UND BETRIEB in German May 92 p 210

[Article by G. Schenkewitz, Magdeburg: "Fraunhofer Institute for Factory Operation and Automation"]

[Text] Joseph von Fraunhofer lived from 1787 to 1826 and was as successful an inventor and researcher as he was a businessman. For this reason he is the patron saint of the Fraunhofer Society for Promotion of Applied Research, reg. assn. (FhG), founded in 1949.

Currently with 46 research institutes and a research volume of 1 billion German marks [DM], it is the largest support organization for applied research and development establishments in Germany.

The Fraunhofer Society employs about 7,600 people.

Target groups for the Fraunhofer Society are small, medium-sized and large companies. The FhG also does research for government clients and for the European Community, primarily in the fields of environmental protection, new energy technologies and safety of technical installations.

In 1990 a restructuring process began in the new laender with the goal of forming a unified research community in Germany. In accordance with its spectrum of tasks, the Fraunhofer Society has helped create new structures for contract research in the laender Brandenburg, Mecklenburg-West Pomerania, Saxony-Anhalt and Thuringia, as well as in the eastern part of Berlin. In April 1991 the senate of the Fraunhofer Society decided to establish 19 Fraunhofer facilities (nine independent facilities and 10 branch offices at existing Fraunhofer institutes). Based on the knowledge that consistent implementation of the FhG concepts in the new laender offer a significant contribution to the realization of the "Recovery East" program, traditionally important industrial regions were chosen as sites for the new FhG facilities.

An independent Fraunhofer Facility for Factory Operation and Automation (IFF) (institute head: Prof. Dr. Eberhard Gottschalk) was established in Magdeburg.

The IFF Fraunhofer facility develops rationalization and automation solutions for creating a market-capable and competitive company structure and is divided into five departments. The development and implementation of high-quality, economical as well as socially and environmentally safe innovation concepts for the most varied branches of industry and service enterprises is an important task for this facility.

The work of the Fraunhofer Facility for Factory Operation and Automation is aimed at discovering and fully utilizing automation and rationalization potentials in companies by means of interdisciplinary cooperation, as well as contributing to their competitive ability by means of suitable forms of organization. In so doing the facility offers to accompany the project from concept to implementation and realization, as a partner for the enterprise.

In addition, work is carried out within the framework of public research programs (such as the BMFT [Federal Ministry for Research and Technology], AIF [Working Group of Industrial Research Associations], DFG [German Research Association], the land of Saxony-Anhalt), which is long-term and method-related.

The focal points for the work of the individual departments is in the following areas:

—Department for Logistics/Production Planning and Control (PPS)

- technical and organizational training for connected links of information and material flow between suppliers, final producers and customers
- warehouse rationalization and automation on the basis of logistic models
- introduction and qualification of PPS models
- training of management centers
- rationalization of operational data collection
- reduction of actual throughput times through weak spot analyses and introduction of control models
- construction site organization
- factory planning and segmentation
- procedures and models for synchronizing purchasing, production and sales.

—Department for Organization of Maintenance

- purchasing of standard systems for the maintenance organization
- integration of technical measures and means in the maintenance organization
- connecting maintenance with PPS and integration in the company's communications system
- application of expert systems in the maintenance organization

—Factory Automation Department

- robot use in processing, handling and assembly processes
- industrial image processing
- development and use of sensors for automation
- automation of transportation, wrapping and storage processes
- establishment of universal automation segments in flexible production systems
- introduction of instrumentation
- local networks

—Quality Assurance Department

- integration of measurement and test methods in the universal aspect of automation
- introduction of quality assurance systems from construction to shipping
- organizational coupling of quality assurance and PPS through quality-oriented machine utilization systems
- development or application, respectively, of expert systems in quality assurance

—Factory Ecology Department

- environmental protection for the overall operation, its individual facilities and various processing levels.

An advantage for the smooth startup of the Fraunhofer Facility for Factory Operation and Automation (IFF) was the many years of good working contacts with the Stuttgart Fraunhofer Institute for Production Technology and Automation and the help it provided.

IFF Magdeburg regards it as an important task to support primarily the small and medium-size enterprises of the Saxony-Anhalt region with extensive research work, utilizing the available project solutions.

A total of 30 employees worked at IFF in 1992. In 1994 their number will grow to 100, with a budget of DM17 million. When the IFF has proved its effectiveness, the name will be changed to "Fraunhofer institute."

LASERS, SENSORS, OPTICS

Germany: Max Planck Institute Develops Advanced Manufacturing Technique for Metallic Microstructures

92MI0686 Bonn TECHNOLOGIE-NACHRICHTEN MANAGEMENT-INFORMATIONEN in German 10 Jul 92 pp 10-11

[Text] Dr. Michael Stuke and his team at the Goettingen Max Planck Institute of Biophysical Chemistry, have successfully used the laser chemical vapor deposition (LCVD) method to create the first unsupported, highly filigree three-dimensional micrometer-sized metal structures with laser beams: The structures are directly written to soluble substrates. The Goettingen laser scientists regard their achievement initially as a breakthrough in basic research, although it is of far-reaching importance for applications, especially in microelectronics and microsystems engineering.

The method involves focusing a laser beam on a specimen, for instance of plastic, while at the same time applying a metal or gas compound, which decomposes at the point heated by the laser. The metal content is deposited and the rest of the reaction product is pumped off. If the sample is turned in different directions, different metal structures are created on the surface of the substrate, for example on a polymer; the desired structures can actually be "written" onto the substrate which is why this method is referred to as a "direct laser writing process." This process of targeted alteration of material properties on surfaces has enabled the researchers at the Max Planck Institute of Biophysical Chemistry's Laser Physics Department, headed by Professor Fritz Peter Schafer, to create a minute three-dimensional structure, rather like a miniature Eiffel Tower, scarcely larger than a matchhead.

Dr. Stuke explains that the targeted modification of the properties of materials can be achieved by applying high-energy radiation, which frequently causes the formation of well-defined layers and layer systems, whose laser-induced production, characterization, structuring, and modification have treated a wealth of new research and application opportunities.

Dr. Stuke adds that the direct laser writing process is of importance for microelectronics applications. His team maintains close contact with industry, for example, through a joint project, funded by the Federal Ministry of Research and Technology, linking the Max Planck Institute of Biophysical Chemistry with three major microelectronics firms. It is also involved in a project that forms part of the joint program on "Material Processing With Excimer Lasers," in which the MPI team is working on the aspect entitled "Ablation with Ultrashort Excimer Laser Pulses."

The direct laser writing process can be used to deposit metals directly on three-dimensional as well as plane substrates. The Goettingen group's research target is therefore to use this method to produce small three-dimensional structures that are free-standing. Dr. Stuke says, "This means we have to find a good substrate for deposition that can also be dissolved and behaves during the dissolution process in such a way as to avoid causing fractures or stresses that would immediately rupture these filigree structures." During the experiment, a laser beam is focused on the substrate, the specimen is easily heated locally, and the gas compound decomposes: according to Dr. Stuke, "Moving the specimen in different directions around an axis enables us to reach every point and thus to deposit a three-dimensional structure."

The laser scientist considers potential applications to include the construction of microsensors or microactuators for use as acoustic sensors or flowmeters. Interest has also been expressed by high-frequency engineers wishing to use the process developed by the Goettingen laser researchers to construct a microwave resonator. Dr. Stuke adds, "We anticipate being able to deposit not only metal, but also semiconductors, superconductors, and ceramics, so in the long term we might reach the point where we can deposit any material three-dimensionally, both in the micrometer range and below." When controlled by software, the process should make it possible to create entire prototypes, down to the submicrometer range.

Dr. Stuke goes on to say that there are also other methods of producing three-dimensional structures, such as the Liga Process, which uses synchrotron radiation. However, this process can only produce structures with vertical walls, which are therefore not truly three-dimensional structures. "This was why we 'built' our Eiffel Tower, as such true three-dimensionality cannot be achieved with the Liga Process."

German University Studies Silicon for Photonics Applications

92MI0723 Bonn TECHNOLOGIE-NACHRICHTEN MANAGEMENT-INFORMATIONEN in German 15 Aug 92 pp 12-13

[Text] "SOI [silicon-on-insulator] Substrate-Based Integrated Optics," is the topic of a research project being

carried out by Professor K. Petermann at the Institute of High-Frequency Engineering at the Technical University of Berlin. His study, which is being funded to the tune of 553,000 German marks [DM] by the Volkswagen Foundation, focuses on the extent to which silicon is suitable as a base material for photonics applications.

The term SOI refers to a silicon disk with a "buried" quartz layer, which can be used for both electrical and optical insulation. The optical fields of these SOI waveguides are very well matched with those of optical fibers of the type used in optical telecommunications.

Hitherto, photonic circuits, for example, have been produced predominantly from complicated mixed crystals. The aim of this project, which the Volkswagen Foundation is funding as part of its photonics program, is to create these circuits on a silicon basis. Among the advantages of silicon are that it combines good value for money with very high quality, and provides a wide variety of opportunities for microstructuring.

The research project centers primarily on achieving the integration of optical waveguides with a receiver photodiode whose spectral sensitivity is controlled by layers containing germanium.

An integrated waveguide/photodetector combination of this kind would be a key element for an integrated optoelectronic receiver, as microelectronic techniques can also be used to integrate the associated electronic circuits into the SOI substrate.

The project thereby opens up the opportunity to use integrated optoelectronics in communications and signal processing, e.g., in fiber-optical computer networking or in fiber-optic waveguide laying.

Further information can be obtained from Professor K. Petermann of the Institute of High-Frequency Engineering at the Technical University of Berlin, Einsteinufer 25, 1000 Berlin 10, tel. (030)314-23346, 22637.

Germany: MBB Develops Bionic Navigation System Modeled on Vertebrate Eye

92WS0725A Duesseldorf VDI NACHRICHTEN in German 26 Jun 92 p 8

[Article by Peter Frey and Heike-Marlene Fuchs: "Private Lessons From Mother Nature: Videochip in Supercomputer 'Brain'"—first paragraph is VDI NACHRICHTEN introduction]

[Text] Wiesbaden, VDI-N, 26 Jun 92—MBB (Messerschmitt-Boelkow-Blohm) is developing bionic navigation systems that are modeled on the vertebrate eye.

Present-day visual processing and pattern recognition systems are hopelessly inferior to even the simplest biological visual systems. Digging into evolution's box of tricks should help engineers to better integrate optical and electronic components. This is why a "bionic eye" is being developed by the Munich-based technology company, MBB. With it in future it would be possible for airplanes or cars to be independently controlled if satellites were in a position to align themselves independently on objects that are of interest.

It sounds like a biblical promise: the blind who can see again, paraplegics who effortlessly get up out of their wheelchairs. What today sounds like an unattainable vision does not seem to the technicians and engineers to be impossible in the future. Purposeful espionage in matters involving evolution has aroused interest among researchers round the world. The scientific excursion into the domain of animal perception is today making it possible for developers employed by big companies to dream of biochips whose switching elements attain the size of a molecule. Optimists even believe in electronic components that grow like flowers in a summer meadow.

In 1992 reality is a more sober affair, but using nature's know-how, which evolved over millions of years, is beginning to interest many firms. Bionics, learning from nature for technological purposes, has arrived in research and development departments. "We cannot, of course, slavishly copy nature, but it's worth our while to make use of its mine of experience," said Helmut Zinner of the Munich armament company, MBB. Zinner knows what he is talking about. For years now he and his team have been devoting themselves to information bionics. Since they started, the entering, storage, and processing of data on living things have been studied in the hope of successfully translating them into technological systems or products. The main focus of this sleuthing is to understand how the visual sense of higher life forms works. Zinner and his colleagues are consumingly occupied with the question as to how animals or humans process visual impressions.

In nature, even the simplest kinds of visual systems are constructed in more complex and more efficient ways in terms of scale than their technological relatives, and this despite the fact that their individual components are apparently put together in a dilettantish way. MBB expert Zinner: "If an engineer were to come up with the same results in developing a camera as nature has in developing the vertebrate eye, he would be fired on the spot. The eye is a poor camera. Its reproductive qualities are unsatisfactory, wires lie across the path of the light beams, the display medium is cloudy, the sensor jiggles." Nature's formula for success lies in optimization of the whole system. Evolution's ability to make compromises has created a visual system in humans that technological developments cannot even come close to in terms of dynamic range and its ability to reduce data, analyze forms, and recognize patterns.

Artificial visual systems are in principle based on a combination of electronic cameras and digital computers subsequently switched on. While the human eye effortlessly manages to reduce the flood of data from the photosensitive cells by a factor of 130:1, the analog process creates great difficulties for engineers. An up to

now unsolved problem is the recognition of patterns, that is, the ability to distinguish important (desired) from unimportant visual content. Even the introduction of neuron networks in the past has led to only modest success.

Now MBB wants to pursue completely new approaches, for which it has already secured the assistance of the Ministry for Research and Technology (BMFT). Such a mechanical or bionic eye could produce navigation systems that can keep a craft on course, avoid an obstacle, or head for a destination on the basis of visual informaiton alone. "Optical flow" is the magic word for the new technology emerging from Munich. The idea has its origin in psychology and can best be explained with an example: A passing car can be photographed either with a stationary camera or with a camera in motion. In the first instance, the stationary background will be sharply reproduced, while the car appears blurred. In the second instance, if one moves the camera in such a way that the passing car is sharply reproduced, the background will appear blurred. This blurriness, which corresponds to the optical flow, can be mathematically calculated with a vector field. Since the individual components of this kind of blurred image move at different speeds, spatial data like rate of rotation, speed, or data on the position of an object in relation to the camera can be determined. In so doing, MBB engineers hope that controls for moving systems that are equipped with only an optical sensor are moving within reach. Robot claw arms would be able to grasp objects in a more precise manner than heretofore and satellites would be in a position to independently align themselves on planets or stars.

[Caption, upper, p 8]

One of nature's brilliant achievements: The eye of a crocodile can see almost as well above and below the surface of the water and is thus superior to technological systems in terms of scale.

[Caption, lower, p 8]

Even the comparatively simply constructed eye of a horsefly would create difficulties for development engineers in reconstructing its entire visual apparatus since, contrary to the way technology operates, in nature whole systems are always optimized in the course of evolution. But a bionic eye today still suffers considerably from [the lack of] a link between optics and data processing.

German Firm's Rapid Prototyping Service Converts CAD Data Into 3-D Model

92WS0725B Duesseldorf VDI NACHRICHTEN in German 26 Jun 92 p 26

[Article by Rainer Hofmann: "Rapid Prototyping Replaces Conventional Model Construction"—first paragraph is VDI NACHRICHTEN introduction]

[Text] Bad Kreuznach, VDI-N, 26 Jun 92—A new service reduces the gap between design and production. Ultraviolet light makes it possible to produce three-dimensional models from CAD data.

The transition from design to the first functional prototypes is often accompanied by time-consuming work done by hand. Rapid prototyping, the photo-optical conversion of CAD data into plastic models, can close the gap here. The Schneider Prototyping Company in Bad Kreuznach has recognized this gap in the market. It now offers rapid prototyping as a service.

Dr. Giora Baum, who is responsible for technology transfer at the Josef Schneider Optical Factory in Bad Kreuznach, predicted: "Probably 70 percent of our orders will involve the production of design models." A member of the Mandermann group, the company recently founded a special firm that devotes itself exclusively to the production of prototypes: the Schneider Prototyping Company.

Design models of utensils or ornaments are supposed to either convey an optical impression or, as with, for example, handles, serve to test the ergonomic properties of the item. It is, on the other hand, different with functional models, which are called for especially when tricky, space-saving designs are involved, for example, in the aviation and space industries, in installation tests.

Such models or prototypes are as a rule produced by hand by model builders who work from drawings either with wood or model molds made of plaster or wax. The first digital prototype systems (3-D systems), which, for example, lithographically convert CAD data into plastic models with laser beams, appeared as early as a few years ago.

Only on the market for a short time now is the "Sturdy" of the Israeli firm, Cubital, which solved the problem with the aid of ultraviolet light. Now the Schneider Prototyping Company wants to offer its services with this type of machine.

Since the design and production of a multitude of industrial products today takes place on a computer screen with the aid of a CAD system. Before it is fed into the actual "prototype," the completed CAD model is sliced up into a large number of thin layers at a work station. Prepared in this way, the CAD data then serve in little slices a pattern for the electrostatic coating of a glass plate, which in turn serves as a mask for the photographic process that follows.

A thin layer of photosensitive lacquer is exposed to ultraviolet light through this mask. After the unexposed areas are washed, the resulting cavities filled with wax, and the plate given a final polishing, the cycle starts all over again. The wax bed makes it possible to produce sharply projecting components as well without any additional supporting structures during the process. After the model is completed, the wax is washed off or dissolved.

In this manner, the model continues to grow in 0.1-mm increments to a maximal size of 500 x 500 x 300 mm.

"The complexity of the resulting model is nearly unlimited with this method," Christoph Kappler, the technical director at Schneider Prototyping explained. Undercuts pose as little a problem as operational machines, as the example of an undivided plastic ball bearing shows. According to Kappler, the maximal deviation of the mass during the process is 0.1 percent for linear measurements. The photosensitive lacquer can, if necessary, be further finished mechanically, lacquered, or metalized in the hard state.

Although it is assumed that the original CAD data are appropriately adapted since every software package operates with its own data format. For several years now, the engineers have been working hard to develop a suitable interface so that construction data can be relatively simply processed in different kinds of CAD environments. One of these interface programs came into being at the instigation of the automobile industry.

Thus version 2.0 of the VDAFS interface permits the exchange of 3-D geometric data. Nearly all marketable CAD software packages today offer the option of converting the data generated into either the VDAFS format or the STL format, the standard format used in laser lithography. These formats are then further processed at the Cubital machine work station.

Obviously, a machine like this one, with the hardware and software that go with it, is not exactly cheap. "The procurement cost of the Sturdy whould be approximately on the order of DM1 million and qualified operators are required," Baum thought. Much too much money for small and medium-sized businesses, which, moreover, could not utilize such equipment to full capacity. But it is precisely these companies that have to quickly and flexibly react to new customers' wishes in order to remain competitive or react to niches in the market.

And now Schneider fills the gap in the market with its service. Baum hopes to constantly utilize the Sturdy to full capacity with the help of a large number of orders. The packing density can also be optimized during production of the model as another method of bringing costs down. In so doing, the computer distributes several objects in the three-dimensional testing room without their colliding with one another, provided that the models are clearly smaller than the maximum possible dimensions. Then an impeller [for example] emerges simultaneously during a cycle next to a handle for a video camera or a household mixer. "In this way it will be possible for us to limit model costs to about DM2,000 per liter of enclosed volume," Baum said.

Aside from the already mentioned automobile industry, as Baum sees it, their chief customers will come from the household appliance and consumer electronics sectors. "We're also working on the production of individual molds for medical implants," Kappler said. Then the model is in turn used in the production of a plaster or silicon mold in which different metals can then be cast. In a still more distant future, Kappler sees the possibility of producing spray molds directly on the Sturdy or of generating anatomical models from computer tomography data.

France: Saint-Gobain's Monocrystal R&D Described

92WS0738C Paris L'USINE NOUVELLE in French 9 Jul 92 p 28

[Article by Jean-Michel Meyer: "Saint-Gobain Ceramiques On the Trail of Photons"; first paragraph is L'USINE NOUVELLE introduction]

[Text] Saint-Gobain is the world's top manufacturer of monocrystal materials for optics and detection of nuclear radiation. The group is counting on an ultramodern facility and research to consolidate its position.

A flight delay has been announced. An anonymous caller has just notified the airport that a suitcase packed with explosives is sitting in the baggage compartment of a plane ready for takeoff. But the airport's security personnel pinpoint the plastic charge in no time, using a detector that employs scintillating monocrystals to identify the loaded suitcase. Irradiated by a neutron beam, the explosives sent back gamma rays, which uncovered the explosives by providing an actual "signature." Security officers had only to compare the signature to the millions of chemical formulas for explosives listed in a computer memory bank.

Pure science fiction? Not at all. Two American firms are running tests in airports. Meanwhile, the Atomic Energy Commission (CEA) is conducting similar experiments for military purposes. Twenty to thirty years from now, that is how explosives and drugs will be detected.

Such studies illustrate the many ways scintillating monocrystals can be applied to the detection of nuclear radiation (alpha, beta, gamma, X-rays, and neutrinos). Saint-Gobain Ceramiques, which has sales of 540 million French francs [Fr], is the world's top producer of scintillating monocrystals and optical crystals. To consolidate its position, and "given the market's expansion" says Pierre-Emmanuel Levy, head of the crystals and detectors branch, the company has decided to combine three of its five European production plants in a new facility in Saint-Pierre-les-Nemours (Seine-et-Marne). The plant will begin operation this summer and become the group's European hub for crystal production. In addition, Saint-Gobain signed an agreement with the CEA in April to transfer its basic research to the optronics department of Grenoble's Electronics, Technology, and Instrumentation Laboratory (LETI).

A Fraction of a Second to Detect a Signal

Indeed, it is not easy to detect nuclear rays. Their ability to pass through walls allows them to make sport of matter: A medium to capture and halt them is needed. And to detect them, it must be a scintillating medium.

The core of a detector is made up of crystals (quartz, silica, etc.) or polymers (naphtalene) which, when struck by nuclear rays, emit a light signal within a fraction of a second. The signal is a dark blue photon with a wavelength of 0.3 to 0.7 micron. Scintillating monocrystals are fabricated in a solution or melted, in a process that takes from six weeks to over two years. Once in place, however, they must react quickly. "To detect the precise moment at which the radiation travels through the matter, the scintillator must emit at speeds of under one nanosecond. Particles can be detected one by one," explains Pierre-Emmanuel Levy. The scintillating body, combined with a photomultiplier, converts the light signal into an electric current.

The patience required to make crystals contrasts sharply with Saint-Gobain's frenetic effort to weave an international web around its Quartz and Silice subsidiary. The group has been shored up since last May by Crismatec, Europe's only manufacturer of laser crystals (sales of Fr30 million in 1991), which it bought from the PSB Industries group. And it was strengthened by the acquisition in 1990 of two leaders in the field: the American firms Bicron, and Solon Technologies, formerly Harshaw. Saint-Gobain also has two subsidiaries, one in Holland and the other in Germany. "This last acquisition completed our portfolio," says Pierre-Emmanuel Levy.

There are five big markets that employ nuclear radiation. They include medicine (scanners, gamma cameras, blood tests, etc.); oil and geophysical prospecting; security (detection of explosives in airports and vehicles); space; and physics (cyclotrons, synchrotrons, particle accelerators, and so forth). French monocrystals have equipped Eurogam—the most sensitive gamma ray detector in the world, located in Great Britain—since April. Finally, monocrystals are used in industry to measure the thickness of metal sheets and the impurities in the fuel supply of blast furnaces.

France's First Gamma Camera

As for optical crystals, which are fabricated in low-temperature solutions, they are used to diffract X-rays (X-fluorescence analysis) after being cut and shaped. Saint-Gobain has a virtual monopoly on the world market. But optical crystals are also used in non-linear optoelectronics and piezo- and pyroelectric applications, which can detect temperature variations in a given field. In one of their many industrial applications, lasers guide coal-cutting machines to the coal lodes.

Saint-Gobain has accumulated a great deal of know-how, which it must now put to work. The Saint-Pierre-les-Nemours facility is the world's first new monocrystal plant in 25 years. Production will be carried out in a dry room at zero percent humidity. "We wanted to build the very latest thing," concludes Pierre-Emmanuel Levy. And France's first gamma camera will roll off the plant's lines on 14 July.

CSO Builds High-Precision Interferometer

Paris L'USINE NOUVELLE TECHNOLOGIES in French 16 Jul 92 p 43

[Article by Bernadette Lacaze: "An Ultra-Precise Mini-Interferometer"]

[Text] With a cell containing rubidium vapor, the latest CSO product offers a resolution of 0.01 microns, or 10 times more than the previous model.

Already familiar to meteorologists for its extreme miniaturization, CSO's interferometer is becoming a measurement standard by virtue of an added wavelength stabilization system using atomic absorption. Semiconductor lasers have already enabled CSO to make miniature displacement sensors combining a coherent light minisource (0.3 x 0.25 x 0.125 mm) with an equally scaled-down interferometer (7 x 7 x 0.5 mm), the latter based on a silicon integrated optics technology developed at Leti. The initial design had a precision of 0.1 microns to 100 mm. To improve this figure and bring it closer to resolution (0.01 microns), CSO and its German collaborator HWS combined the basic components with a cell containing rubidium vapor, whose particular property is absorption of emitted light at certain specific wavelengths, with maxima at 780.023 nm and 780.036 nm. Because they are based on atomic properties, these values are absolutely stable with time and close to the wavelength of 780 nm emitted by the diodes used.

This wavelength can be slightly modified (within a range of +/- 2 nm) by changing the diode's temperature and current. An ultra-high speed photosensor measures the absorption. The result is read by the electronics, which then regulate the laser supply for the closest wavelength adjustment. This device yields a better than 10^{-7} stability for the emitted wavelength.

The interferometer provides a measurement resolution of 0.01 microns for moving objects between 30 and 300 mm, whether the motion is slow (0.1 microns in 24 hours) or fast (60 mm/s). A precision of 0.03 microns is obtained in measuring the displacement of an object in motion at a distance of 100 mm from the sensor, a temperature of 20 +/- 1.5°C and a pressure of 1013 +/- 1 mbar.

The interferometric sensor's extremely small size (the cylinder's diameter is 17 mm and its length 104 mm) allows it to be integrated directly into a measuring device, a translation table, a metrology feeler, a durometer, or a precision extensiometer.

Philips Unveils New Electron Microscopes

92WS0777A Paris AFP SCIENCES in French 23 Jul 92 p 14

[Text] Eindhoven—The Philips Electronic Microscopy company has just developed two new high-resolution-transmission electron microscopes through a project sponsored by the European research program

BRITE EURAM. The CM 20 and the CM 30 FEG feature field emissions of 200 and 300 kilovolts.

The CM 20s have resolution of one angstrom, which corresponds to the atomic structure of several materials. The new microscopes incorporate significant technical improvements, notably a very focused and brilliant electron source, and a new Ultra Twin cooling lens that guarantees samples will remain stable during observation.

Europe's four-yearly BRITE EURAM research program provides the funding for the project. The BRITE project should enable Philips Electronic Microscopy to achieve resolution equal to or even lower than one angstrom within two years, to enable scientists to observe most atomic structures.

Germany: Development of Laser Industry, Technology

Technology, Marketing Position

92WS0790A Duesseldorf WIRTSCHAFTSWOCHE in German 21 Aug 92 pp 58-65

[Article by Wolfgang Mueller: "Classy Attacks"]

[Text] The advertisers from Mercedes-Benz AG have long known how to capitalize even on flops in order to benefit their image. Although the plush coaches of the new S-class are not exactly best sellers, the Stuttgarters are proudly celebrating a new "stellar hour of technology" in manufacturing the 2.2-ton vehicle. Not entirely without justification: Mercedes is the first company in the international automobile industry to have dared the attempt of instant, full integration of two laser welding facilities into their body building, without a safety net and a double floor, so to speak, meaning without a stand-by facility or buffer down the line—that is to say without any kind of guarantees in case of failure. The systems weld the rear fender to the body.

For Friedrich Stockinger, chief of laser manufacturing systems at Maschinenfabrik Trumpf GmbH + Co., which has delivered the systems installed at Mercedes, this first in worldwide automobile construction is conclusive evidence of the competitive ability of German laser technology. And Trumpf CEO Berthold Leibinger, who is simultaneously president of the German Machine and Plant Engineering Association (VDMA), is patting the industry on the back: "Through their close links with science and industry the German manufacturers have now reached a top position in the world market."

In order to defend against the aggressive price dumping of the Japanese, domestic suppliers are increasingly entering the field of advanced solutions. The most important user of innovations in the laser field is the automobile industry. At Ford in Genk in Belgium, at Audi in Ingolstadt and in prototype manufacture at the Volkswagen Works in Wolfsburg, cutting, drilling, welding and finishing is now being done by means of lasers.

"Collapsible section optimization by systematic hardening and softening of body sections by means of laser," is mentioned by Dietrich Zeyfang, head of technical work at Mercedes-Benz in Bremen, as the next field of application, which is already under intensive development. And Professor Gerd Herziger at the Fraunhofer Institute for Laser Technology in Aachen knows from his own experience: "Whenever an application field is even half-way saturated, in parallel with it entirely new fields are already in the growth phase."

The technological leaps which go along with this, as well as the price attacks of the Japanese competition, are giving domestic suppliers a lot of trouble. Despite a continuing boom in the market, the manufacturers of industrial laser systems suffered an 8 percent drop in sales last year. But now there is hope again: The market volume in this field—according to prognoses by the Lasers in Materials Processing working group VDMA in Frankfurt/Main—will increase worldwide from a little over 2 billion German marks [DM] in 1991 to DM3.8 billion in 1995. Japan is now the largest sales market for laser systems in the western world with a share of 43 percent, the United States follows with 31, and western Europe gets 26 percent.

In the production of laser sources and systems, on the other hand, German companies such as Siemens subsidiary Rofin-Sinar Laser GmbH in Hamburg, Lambda-Physik Gesellschaft zur Herstellung von Lasern mbH in Goettingen, Baasel Lasertechnik and the engineering firm of Trumpf in Swabia, are alone at the top of the list of world-ranked firms. Approximately 45 percent of their products were exported in 1991. Based on value, over one-third of the laser sources produced worldwide for materials processing come from Germany, and for laser systems the German share in 1990 was 13 percent.

Detailed market prognoses for individual industrial branches turn out to be increasingly more difficult, because even today the laser systems are as fundamentally different as their application possibilities. Tiny semiconductor lasers with crystal fragments of indium-gallium-arsenide-phosphide are used in communications technology, for example, solid state lasers in the most varied forms of construction are used in medical technology and for particularly fine work in materials processing. So-called excimer lasers, which emit ultraviolet light and consequently do not heat up the material in cutting, can be found in microelectronics and chemistry, while cheaper diode lasers with output in the milliwatt range do their job in CD players and computer printers.

Nearly one-quarter of all equipment used now in industry and medicine are carbon dioxide lasers. The CO_2 laser units, which sometimes cost several hundred thousand marks, are the work horses. They cut, weld, drill and finish surfaces.

However, Michael Eyett, project director at Prognos AG in Basel and the author of a brand new laser study, is already envisioning a radical change: "Solid state lasers will increasingly break into the domain of the CO_2 lasers, while the CO_2 units will grow into the higher performance dimensions."

But analysts expect the highest growth rates in the coming years to be in communications and data technology. Compact disc memories, laser printers, wireless data transmission and fiber optics are only the first emissaries of a development which could lead to sales increases comparable to those in the personal computer industry in the 1980s. Here as well German researchers are already up at the forefront: At Bremen University chemist Guenter Schulz-Eckoff recently presented an operational memory for an optical computer. A laser with a specific wavelength activates dye molecules in a zeolite crystal grid in such a way that they can no longer absorb light. But at another wavelength the dye is again able to absorb light. This revolutionary effect can be used to store information. According to inventor Schulz-Eckhoff, "the data can be compressed as densely as the genetic information in the nucleus of human cells."

Frank Sporleder of the Research Institute of the German Bundespost Telekom in Darmstadt has even observed "a regular race to produce the most practical information laser" over the last few years. Despite some remarkable results in this country, the first round went to the competition from Japan, however.

But even in the field of materials processing there is growing fear among German manufacturers—despite their good position in the world market—of aggressive, cheap suppliers from Japan. The opponents are called Fanuc, Mazak and Amada. "I think that in Japan there is a strategic goal to dominate the laser market just as the camera market," Trumpf marketing director Leibinger fears. The Swabian machine tool and CO_2 laser manufacturer (annual turnover in 1991: DM723 million) is now reacting to the challenge by establishing a new foothold. On 1 July Leibinger acquired 40 percent of Haas Laser GmbH in Schramberg, a leading company in the promising field of solid state lasers (annual sales in 1991: DM33 million).

In addition, the Ditzing people are concentrating on technical innovation. Together with the Fraunhofer Institute for Laser Technology in Aachen, Trumpf is developing a "third-generation high-performance laser." While the 10,000 CO_2 industrial lasers in use worldwide today—about 2,500 new installations are added each year—meet the performance need up to 14 kilowatts, the new beam bundles are intended to produce 40 to 60 kilowatts. Such a powerful device can even cut 20 millimeter-thick steel sheetmetal with a speed of more than a meter per second.

Some manufacturers from the industrial sector are also looking to secure their business health with medical lasers. Depending on the type of laser these fuse retinas in the eye, break up kidney, gall and bladder stones, open up constricted blood vessels or stuck together Fallopian tubes, combat paradentosis or remove tumors without bleeding. Despite these various possibilities the medical laser market in Germany is "still developing very slowly," according to Andrea Vorthmann of Heraeus Instruments GmbH in Hanau.

The lasers from Lambda Physik GmbH also operate predominantly in the microfield. The company, founded 21 years ago, has now advanced to become a world market leader with a share of 70 percent of excimer lasers, which now are primarily used in chip production. With its 750-watt lasers Lambda is regarded as an exemplary model of German innovation in laser technology. "In order not to fall behind technologically, the Japanese at the moment still have to buy our products," Basting brags, "because we now have a development lead of three to five years."

Market Study: The Europeans' Pent-up Demand

The period of a sharply growing laser market even during the economic slump now seems to be coming to an end. At least it is possible to sense a certain feeling of insecurity after two years of scant growth. But the most recent market study by Prognos AG in Basel of the international situation in laser technology also indicates that, despite the modest growth, the market for laser sources has hardly lost its attraction.

The value of laser-equipped devices exceeds that of the actual source many times over. For materials processing systems Prognos mentions a factor of between four and five, for medical lasers it is between five and six, in measuring technology 20 and in information and communications technology up to 60. Laser sources thus represent a world market of DM30 to 40 billion a year.

According to the Basel analysts it is cause for concern that the Japanese, who already dominate 70 percent of the global laser market in information and communications technology, are now fighting it out for a leading position in materials processing as well. They have already reached the 50 percent threshold, although in this field the German companies, for example, are number one technologically.

The Europeans have a pent-up demand anyway in the field of semiconductor lasers, since their application fields are expanding with increasing performance. Such high-performance components are being further developed by U.S. companies, among others, who until now were involved in defense technology and acquired know-how in that area. Semiconductor lasers can replace bulbs in cars or traffic information boards. Physicians are already using them in eye surgery, and it is only a matter of time before they will be used for marking and soldering. Further, they can help other lasers under development, primarily solid state lasers for materials processing.

Market researchers from Prognos record a further increase in suppliers—from new companies being founded and from large conglomerates which are diversifying in the field of laser technology. Due to the global character of the laser markets one can, on the other hand, note a growing tendency toward concentration by means of takeovers and strategic alliances.

Laser Sensor Systems

92WS0790B Duesseldorf WIRTSCHAFTSWOCHE in German 21 Aug 92 pp 65-67

[Article by Hartmut Kowsky-Kawelke: "Scouts for Robots"]

[Text] Marius Jurca is a high-tech businessman par excellence. Immediately after his studies the young graduate engineer decided on the path toward independence. Today—10 years later—he employs 16 high-level experts in his Jurca Optoelectronic in Rodgau in Hesse, people who successfully frolic in the still young field of laser measuring technology. The company develops and produces systems which are now finding a hot market in industry and environmental analysis. Jurca has a crystal clear explanation for the high demand for his products: "The constantly shrinking production cycles, as well as the permanently growing desire for quality, require non-contact, precise and fast measuring methods, which today can only be provided by laser sensors."

For the manufacturers of laser sensors the present annual growth rates of 20 to 40 percent are not a rarity, because their systems with increasing frequency penetrate into extreme fields that are difficult or impossible for other instrumentation to access. In mining, for example, color sensors have been used to control the excavating machines, sensors which are able to differentiate precisely between coal and rock. Jurca uses the same principle for recognizing paper money and check-cashing cards. "For the Federal Criminal Police Bureau we were able to determine with our color measuring technique that two counterfeit banknotes came from the same forgery facility," according to the startup businessman.

Since this spring Ferrotron GmbH in Moers on the Lower Rhine has been offering a new laser-optical survey system under the name of Tachymeter. It is already being used at Thyssen, Krupp, Hoesch, Mannesmann, at Dillinger Huette and British Steel, to examine steel converters. The Ferrotron engineers have recognized another market opportunity in their function as service suppliers. "We make appointments to come to the steel plants and check out the thickness of the lining," Rolf Lamm, who heads the Electronics Division at Ferrotron, outlines this new business field.

This is highly profitable for both sides. After about 800 trips, which is what steel cookers call a production cycle, until now the converters had to be shut down in order to receive new bricking. Normally, the lining is not used up. But after 800 trips the steelmakers want to avoid the danger that 380 tons of liquid steel could run out uncontrolled through a leak. With regular laser-optical testing of the thickness of the wall, a converter does not have to be shut down until it actually shows weak spots. Now, up to 1,000 trips are achieved.

Siegfried Wienecke, managing director of the young Westphalian instrument engineering company Gesellschaft fuer Messtechnik mbH Mesacon, also has a dynamic feeling. Four years ago when Wienecke started out in Dortmund's Technology Park he was the only employee. Today close to 50 men and women work for him in the same place. This development is not a surprise to Wienecke: When he founded the business he came across a Japanese study, which at that time listed exactly a few hundred laser applications. For 1993 it is already predicting several tens of thousands of application possibilities.

Wienecke decided to utilize the auspicious moment. He first developed length-measuring systems for the steel industry. Today, his non-contact laser systems still measure the speed of the product passing by and thus its exact length. What worked in the rolling mills is now being applied by Mesacon customers in foil production and in the manufacture of insulating materials. The laser sensor is always used when contact with the material is not possible or its surface would be deformed or damaged.

A nearly revolutionary development comes from the house of MBB (Messerschmitt-Boelkow-Blohm GmbH). With the Scout, which is a seam tracking system, the Deutsche Aerospace systems company in Ottobrunn succeeded in adapting an industrial product out of a former military application. The Kuka Schweissanlagen + Roboter GmbH now plans to use Scout as an intelligent eye for its welding installations and robots. The Scout is a laser-based image processing system, which consists of a sensor at the tool and an electronic evaluation unit. The sensor itself contains an active laser and a camera, which records the reflected light signal and sends it for further processing to a parallel computer system. Here the quality of the welded seam is examined and, if necessary, the position of the machine tool corrected. Measurements are undertaken every 20 seconds. The high computing capability makes welding speeds of 20 meters a minute possible.

But MBB is not the only one jumping into the civilian market with the Scout. Almost simultaneously the Ottobrunn company is offering its Focon laser beam control system and the Lass laser switching system. Klaus Barthel, in charge of laser products at MBB Deutsche Aerospace in Ottobrunn, is certain that he has two more successful products: "The great response to the Scout system shows that the step of going to a civilian application with our military know-how was absolutely correct."

Research Into Laser Safety

92WS0790C Duesseldorf WIRTSCHAFTSWOCHE in German 21 Aug 92 pp 67-69

[Article by Erny Hillebrand: "Deadly Lightning Bolts"]

[Text] There is a sharp hiss and the man lies dead on the ground. A lightning bolt from a laser pistol hit him square in the heart and drilled a millimeter-large, bloodless hole in his body. "Such scenes are only found in science fiction movies; handling the laser beam is much safer than you think," Rainer Roehrig, department head at the Federal Ministry for Research and Technology (BMFT), reassures those who have a sensitive nature.

A study within the framework of the Eurolaser European technology program proves that the BMFT specialist for laser research is right. It says in this study that all fatal accidents so far in handling industrially applied laser technology were caused by electrocution. The extensive bundling as well as the high energy density of the laser beam could lead to eye and skin damage, to be sure, but this risk is relatively low due to the normally complete enclosure of the beam. "In comparison with competing technologies, such as plasma cutting, working with the laser is even considerably safer," confirms Klaus-Dieter Nowitzki, an advisor at VDI-Technology Center for Physical Technologies in Duesseldorf, which as the principal investigator is carrying out the BMFT's laser project.

Nevertheless, Nowitzki sees "specific dangers, which urgently have to be studied." So far, the BMFT has determined unstudied sources of danger, which occur primarily when the laser beam hits the material to be worked on. In the opinion of BMFT expert Roehrig: "We do not yet know what can occur during this and what health consequences such a laser accident could have."

A precise exploration of possible problem areas has not been possible until now even at considerable expense. Thus, the dust particles which are released in drilling, cutting or stripping by means of laser are often so fine that they are not even included in the existing work safety rules. Chemical reactions with toxic end products can occur, above all when processing synthetics.

"We note a growing potential for danger, to some extent already with fatal accidents, in maintenance and installation of laser systems used in industry," stresses Ruediger Peuker, department head for laser beams at the Professional Association for Precision and Electrical Engineering in Cologne. As far as Peuker knows, it is usually electrocution which leads to serious accidents. The expert has recorded more eye and hand injuries, which are caused by the direct touch of a laser beam. In medical applications the danger of fire and explosion plays a major role. In single cases patients suffered fatal burns because materials in the operating room caught fire. Others were injured in explosions, after gas lines had accidentally been hit with the laser.

In order to clearly recognize the dangers and ultimately to reduce them, the BMFT is funding approximately DM10 million of two research projects on the subject of laser safety, which are to be concluded within the framework of the European EUREKA technology program in the summer of 1995. Under the leadership of the laser center in Hannover, the participants include leading German laser research institutions such as the two Fraunhofer Institutes for Laser Techniques and Production Technology, the Federal Institute for Materials Research and Testing and various institutes of higher education. A total of about DM56.6 million is being spent by the governments and the 84 European companies, research institutions and colleges which are involved in the two projects—Laser Safety in Medicine (Stilmed) and Laser Safety in Materials Processing (Eurolaser-Safety-Indal). "Compared to other research programs a rather large amount for preventive safety research," in the opinion of VDI technology adviser Nowitzki.

The goal for the ambitious Euro-program is to increase the competitiveness of the European laser industry. To this end not only are the work safety laws and safety standards in Europe to be brought to the most current level of technical development, but new airing and ventilation systems, filter techniques and gas and aerosol sensors are to be developed. In addition, besides establishing a data base for laser safety, training and advanced education programs are also part of the project catalog.

In addition to 11 western and northern European countries, the Commonwealth of Independent States (CIS) and Israel have also announced their interest in the industrial laser project. The project's comrades-in-arms from German industry are already handing out premature praise with a view to international interest: "By participating in such long-range projects on a level above individual companies, we want to create a basis for future strategies for our firm in the field of laser applications," is the reason given by managing director Reinhart Poprawe of Aachen's Thyssen Laser-Technik GmbH for his company's involvement in the EUREKA project.

MICROELECTRONICS

SGS-Thomson Plans Ultramodern BiCMOS Plant

92BR0592 Paris ELECTRONIQUE INTERNATIONAL HEBDO in French 25 Jun 92 p 10

[Article by Francoise Grosvalet: "SGS-Thomson: Top Level for BiCMOS"]

[Text] The Crolles center is to become more than an R&D center linked to a pilot plant; it is to become the main SGS-Thomson BiCMOS [bipolar complementary metal-oxide semiconductor] production site. The decision has been made; funding remains to be arranged.

With the eventual possibility of accommodating 3,400 square meters of clean rooms (45 percent in class 1, 55 percent in class 100), which would outdo the Japanese according to Joel Monnier, head of central R&D at SGS-Thomson, and even if initially only 2,000 square meters are outfitted, the Crolles center will become much more than an R&D center linked to a pilot plant. The goal really is to make it one of the most advanced BiCMOS production centers in the world. The decision has been made, funding remains to be arranged. Concerning the latter, the decision should be made in the course of 1994 so that large-scale production can be started by 1995-1996. This does not mean, however, that in the mean time the Crolles center will confine itself to pilot production runs. Its current production capacity of 2,000 200-mm wafers per month exceeds the needs of the joint SGS-Thomson/CNET [National Center for Telecommunications Research] center. The preproduction stage (up to 5,000 wafers monthly) can thus be reached without enormous additional investments: Some instruments will indeed be saturated while others, in particular the ion implantation devices, will only be used at 30 percent of their capacity during the pilot plant phase. However, this will not be the case for the upgrade to genuine mass production, which is the ultimate goal of the center that is to become the SGS-Thomson's prime BiCMOS site.

In addition, the Crolles center also seeks to improve its know-how in manufacturing sciences (a completely separate discipline, according to J. Monnier) by introducing the "time to market" notion at all stages, including the development stage. For this reason, R&D and manufacturing activities have been combined at both the sites of Crolles and Agrate. In fact, this blend makes it possible not only to decrease investments (some of the equipment is shared), but also to implement industrial R&D methods (this is essential for future industrialization) and to base the definition of industrial tools on R&D criteria. This results in higher yields. In the R1 site, for instance, where the CMOS technology for the company's 4-Mbit EPROMs [erasable programmable read-only memories] has been developed, the yield currently exceeds 70 percent for this type of product. This is due essentially to the work methods employed. As Fabio Gualandris, chief of the Agrate pilot plant, notes, "although tools represent 20 percent of success, the essential contribution is made by people." These methods, which were to a large extent copied from the Japanese, leave lots of room for suggestions by operators according to the LTA (listen-think-act) principle, with good equilibrium among the three components. At Agrate, each team has its own time-variable objectives so that each phase is readily accessible (question of team motivation). Result: Less than one error per operator per year.

Objective: Standardization of Computer-Aided Design

The Crolles center, which will be operational in September, will have a modular structure (class 1 module for the work zones, class 100 for the maintenance zones); this provides for great flexibility for future expansion. The level of automation will not be very high but, as J. Monnier points out, even the Japanese are abandoning their concept of total automation. "In Japan, more and more people are manning the production lines," he specifies.

However, technology alone is not sufficient, it has to be supported by reliable design methods. CAD [computer-aided design] is the responsibility of Jo Borrel (central R&D includes 800 persons distributed over four sites of which 150 are solely focusing on CAD). In this field, as is the case in manufacturing, the company objective is to standardize technologies at all sites. This standardization will allow the pooling of libraries among divisions, which will increase design productivity. This centralized CAD activity will use tools that are available in the market (SGS-Thomson has partnership agreements with Cadence, Synopsys, and Anacad) as well as some in-house developments.

German Software To Assist in ASIC Development, Production

92WS0705A Duesseldorf VDI NACHRICHTEN in German 12 Jun p 28

[Article by Jens D. Billerbeck: "Compass Successful in its First Year"]

[Text]

ASIC Design Independent of Chip Fabricator

First Chip with 1 Million Gates to Be Finished Soon

Application-specific integrated circuits (ASICs) are developed, simulated and prepared for production today using specialized software programs. Over one year ago, in March 1991, the Compass Design Automation Company appeared in this market and operates worldwide since then. Henri Cristini, Vice President for Europe, and Dr. Franz Riedlberger, responsible for Central Europe, summarize the first year.

Although Compass appeared on the market as a newcomer, there were many old hands at work. The company is a subsidiary of the semiconductor fabricator VLSI Technologies. The company arose from the software workers of VLSI and was formally founded on 5 March 1991. Henri Cristini, vice president of European Operations, explains the preliminary considerations. "In the past, there was one problem for customers. The software for ASIC design was always coupled to the chip factory. One set of software, one library, worked with one factory. Besides, the development expense for software is very high. No money can be earned by serving only one chip fabricator. Consequently, we at VLSI Technologies decided to enter the market with a new company and to offer software independent of the chip fabricator."

His colleague, Dr. Franz Riedlberger is director of the Munich branch for Central Europe. He adds, "We not only have the software but also the libraries of various chip fabricators. These are the rules for practical conversion into hardware. With our tools, the customer can change his design for a different factory with a few settings, even after the design phase."

In this way, the developer saves valuable time in the end. It is precisely time that has become a competitive factor today. "We want to give the user very efficient tools to keep the turnaround time short," says Cristini, describing the strategic direction of Compass.

At this time, the company has agreements with six fabricators that can produce chips developed by the customers. Cristini says, "We have the rights to the libraries and therefore we can offer the entire palette. Not only schematic entry, simulation, but also things such as floor planning, a bonding editor, or test program interface. Put into simple terms, we cover everything from the abstract description language VHDL to the silicon."

Worldwide, Compass has 270 employees, 57 in Europe. There are 180 employees in research, development and support alone. The European research center is located in Sophia Antipolis in the south of France. Cristini calculates that about 70 percent of all activities at Compass are engineering activities. For the customers, this has the advantage that the tools were developed not primarily by software specialists, but by people who understand something about ASICs.

"Consequently, we don't just sell pure software," explains the European chief. "All of our people come from silicon and therefore our customers have the possibility of gaining silicon expertise." In Munich, for example, he has collected about 30 man-years of ASIC design experience. "We can pass this experience on. Of course, we are not a design house but when problems occur in using our software, we can help."

Who are the customers working with Compass tools? "Everyone making ASICs is a potential customer," explains Cristini. He sees ASIC areas of application, for example, in telecommunications, data processing and, recently, even in the industrial market to a greater degree.

Both managers were very satisfied with the first year. However, Cristini wants more. "The market penetration is not as great as it should be. While we are a startup company, that does not apply to the product. The basics of the product were already developed at VLSI." Despite this, Compass has been profitable since the second quarter of its existence. This was in spite of the fact that, at the time of the founding, the market already appeared divided. Cristini reports that in 1990, the market leader Mentor had a market share of 37 percent, followed by Cadence with 19 percent and Valid with 15 percent.

Even then, Compass, or the appropriate division of VLSI Technologies, was in sixth place worldwide with a market share of 2 percent. Today, he envisions a share of 5 percent for his company. Cristini says, "Our entry into the market has been accepted. While the total business of the branch has declined, if the company can maintain revenue, it is doing well."

He sees primarily one reason for the positive result. "Precisely in recessionary times, development tools such as those we produce, are of interest. Our software helps our customers to create new products and new markets thereby coming out of the crisis."

Even complex designs are no problem. Riedlberger says, "Our software can handle gate arrays, standard-cell designs or pure polygon wafers for precision work on the finished layout." For the user, there are no differences. Depending upon the complexity and expected performance, different procedures are possible. The Compass man from Munich points proudly to the first chip having one million gates to be finished shortly.

Riedlberger says, "Before, anything larger than 80,000 gates was a fabricator-specific design. Now, we can handle the large designs, even independent of fabricators." He points to the ASIC Navigator in this context as the flagship of the Compass program. This is a software package that allows graphically oriented entry of descriptions in the descriptive language VHDL. This language has developed into a de-facto standard recently when the representation of very complex chips and systems is involved. "We are convinced that the future belongs to VHDL," says Riedlberger. However, "Engineers are very graphically oriented."

Now, however, it still is true that many chips of low complexity are pasted together from individual gates on the screen. "This is because of the conventional design tools," believes Riedlberger. "Advanced tools are still not very widespread. However, at 100,000 gates and above, the traditional method must fail."

France's Planecran Develops 10-Inch Display

92WS0713B Paris AFP SCIENCES in French 9 Jul 92 p 20

[Text] Paris—AFP SCIENCES learned 8 July at the National Telecommunications Study Center (CNET) that a Planecran team has developed a flat, color, liquid-crystal screen and integrated it into a microcomputer model. The team is working for the CNET and the Company for General Electrical and Mechanical Applications (SAGEM).

The useful surface of the screen, whose liquid crystals are controlled by an active matrix of thin-film transistors, is 211 by 158 mm, or 10 inches across diagonally. Its complexity of 480 lines on 3 x 640 columns meets the VGA standard for microcomputers.

This French victory in the race to develop flat screens was made possible by a new process devised in Planecran's pilot factory in Lannion (Cotes-du-Nord) and patented by the CNET. The process, the CNET stresses, "improves quality and especially industrial output." Only two masking levels are required to deposit a matrix of active transistors, compared to four or five levels in competing, and particularly Japanese, products.

Planecran is a 50/50 consortium formed by the CNET and SAGEM nearly four years ago. Its goal is to pave the way for industrial production of active-matrix screens that employ CNET technology, primarily for applications in telecommunications, office automation, and data processing.

Germany: Institute for Integrated Circuits Profiled

92WS0719A Munich ELEKTRONIK in German 7 Jul 92 pp 20-21

[Text] The Fraunhofer Institute for Integrated Circuits [IIS], which is located in Erlangen, is directed by Professor Dr.-Engineer Dieter Seitzer. This divisioin of the Fraunhofer Society has set itself the goal of sponsoring innovative system solutions for new products of industry through the use of the most modern microelectronics. A particular center of focus is related to solutions in the design and realization of ASICs, in the use of micro- and special processors, and in the use of intelligent sensor technology and electronic systems (telecommunications, for example).

Customers are for the most part small and medium-sized businesses, as well as the federal government, the federal states, and the European Community.

The institute has at its disposal offices and laboratories with a total area of 5,000 m^2. By the end of the year the number of employees will have grown from 92 to 130, mainly as a result of the fact that increasingly more development projects are being managed and successfully completed here.

A development which is completely relevant to present needs is the Forth-Risc processor, which was first manufactured in 1989, and an improved version of which was exhibited at the CeBIT '92. This 16-bit microcontroller is suitable for the rapid performance of programs which are written in Forth or in other high-level languages. The chip has a complexity of 9,000 gate equivalences, and is manufactured in 1-µm-CMOS technology (Sea-of-Gates) with two metallization layers. The design, simulated with Verilog-XL, is described in Verilog-HDL. A second interesting IC development, multichannel speech transmission over a line by menas of a frequency multiplex, has already been described in Issue No 1 '92 of ELEKTRONIK on page 16. Each transmission station essentially consists of a 4-bit microprocessor, a multiplexor circuit, which was developed to be user-specific, and a few additional components. The processors in each station are programmed with complete control and switching software.

For brightness control of modern energy-saving lamps and normal incandescent lamps, in the same circuit a further CMOS ASIC circuit element was developed, which generates control signals with analog and digital components. The analog component contains a phase-locked loop for the generation of a cycle which is synchronous with the power frequency, and also a zero crossing recognition of the supply voltage.

In the digital component the control signal for the output component is generated through various chains of counters. The brightness is regulated by means of keys, which set the value of a reference counter.

Subsequently in the Institute of Integrated Circuits solid-state microwave ICs will also be designed and tested, and gallium arsenide circuits for ultra-fast A/D transponders developed. A project which might be of interest primarily to smaller and medium-sized businesses is called the Multi-Project-Wafer.

German Institute Pioneers Diamond Chip Technology

92MI0727 Bonn DIE WELT in German 3 Sep 92 p 7

[Article by Norbert Lossau: "The Chip of the Future is Made of Diamond—The Foundation Stone for a New Era in Electronics Has Been Laid at a Fraunhofer Institute"]

[Text] Resistant boring heads with an ultrathin diamond coating are already in use today. The coating process is carried out with an electrical discharge in a chamber containing a very special gas mixture that also contains carbon atoms, which are used to build up the diamond crystals.

The Chinese scientist Xin Yang from the Fraunhofer Institute of Coating and Surface Technology in Hamburg has now succeeded in inducing the first-ever precisely oriented growth of a diamond layer on a silicon crystal. This brings the vision of diamond-based microelectronics one crucial step nearer to reality. Indeed, it is perfectly possible, in principle, to use diamond to produce microelectronic circuits: Its crystalline structure is the same as that of silicon, which is currently used to produce chips, and it possesses similar electrical properties.

Compared with silicon chips, diamond chips would have a whole series of advantages. They conduct heat at least 12 times as well, so more transistors per area unit could be integrated on the chip. As a consequence, the chips would work faster.

However, transistors, diodes, and resistors can be created in thin diamond layers only if, like the silicon currently used in chips, they do in fact consist of one single homogeneous crystal. So far, the researchers working on making diamond electronics a reality have succeeded in producing only polycrystalline diamond layers, consisting of many single crystals, on a substrate.

Meanwhile, bringing silicon and diamond together to form a sandwich opens up application potential in the shorter term. The diamond coating would enable even today's silicon chips to eliminate the heat produced by the electronic components more effectively. In view of the hardness of diamond, the layer would also offer good protection against mechanical damage.

German Institute Studies Microsystem Technology

92WS0785B Frankfurt/Main FRANKFURTER ALLEGEMEINE in German 12 Aug 92 p N3

[Article by Brigitte Roethlein: "On the Road to Microsystem Technology: Combinations of Sensors and Electronics/Varied Applications"]

[Text] There are only a few areas in which development advances as fast as in microtechnology. The Fraunhofer Foundation took this trend into account and provided its Institute for Solid-State Technology (IFT) in Munich with a large new building which provides the capability for development of extremely modern semiconductor technology and microsystem technology. The federal government and the Free State of Bavaria shared the financing of the 100 million German mark [DM] project 50:50. Annual operating costs will be DM20 million and about 80 percent of that is covered by its own earnings.

What began in the 1960s with microelectronics and suddenly revolutionized the entire economy, continued during the 1970s with a perfecting of the technologies. It was possible to increase the efficiency and accuracy of the components and to increase yields. Since 1980 miniaturization of electronics has extended to sensor technology as well. Sensors which used to be the size of a fist, such as the water level indicator in the washing machine were reduced to millimeters. Sensors for new tasks were continually added, particularly for the measurement of chemical quantities; biosensors also assumed increasing significance.

In the 1980s fabrication of so-called "actors" began. In contrast to sensors, which almost "feel," actors "act", i.e., they execute orders. In an analogy with humans, sensors are the sensory organs whereas the actors represent the limbs. The brain, which forms the link between the two areas, is microelectronics. These efforts received a critical impetus in 1987 when a micromotor with dimensions of 0.2 millimeters was introduced in the United States.

For the 1990s, the trend toward system integration is emerging. Whereas until now the emphasis was on individual sensors or actors, their modes of operation, and their production, it is now increasingly going beyond that to combine components and produce miniaturized intelligent products, which can independently collect and evaluate data and perform resultant actions. Thus, the discipline known as "microsystem technology" was born. The IFT will commit itself precisely to this area.

According to a Battelle Institute estimate, the world market for sensors will reach a volume of approximately ECU25 billion by the year 2000. More than 70 percent of that is expected to be miniaturized systems. Potential applications for microsystems are virtually everywhere: In environmental protection, they are used for decentralized monitoring and analysis, in measurement, control, and regulation technology for adjustment of flow volumes, chemical quantities, or pressures. In the automobile, they are used as airbag triggers, and also fuel level indicators; in the future they will also be used inside the engine to monitor the chemical parameters.

Microsystems are particularly important in medical technology: There they can dose medications precisely, constantly monitor blood values, and also be used in endoscopy. In this area there is an even greater need for reliable miniaturized instruments. In mechanical engineering, precision mechanics, and optics, the primary need is for mechanical sensor systems which measure and control accelerations, pressures, and flow volumes. A system which is already widely disseminated, which is however still relatively large, is the autofocus control of modern cameras. Microsystems will also soon be indispensable in household appliances.

Silicon plays the critical role in microsystem technology. As the head of the department at the IFT, Hermann Sandmaier, says, silicon is the most thoroughly researched material. In addition to its semiconductor function, it has excellent mechanical properties: low weight, good heat conductivity, high elasticity. Another deciding factor is the fact that the processes for handling it had already been tested in great detail in microelectronics.

One successful example is a pressure sensor which has an accordion-like structure. In the former pressure sensors, temperature variations created tensions between the sensor and the support since the thermal expansion of the materials is usually of different intensity. This effect often significantly distorted pressure measurements. In the newly developed sensor, the bellows-like structure absorbs stresses and mechanically decouples them from the housing. Thus, measuring precision is significantly increased. The entire sensor has a size of 5 x 5 x 0.5 mm. The production of the fold structure was developed at the IFT using a multi-step etching process.

The development of exact dosing pumps for minute amounts of fluid is another application which has multiple uses. At the IFT, a micropump with no movable parts has been developed. A voltage which exerts a force on charged particles in the fluid is applied between two silicon gates. This is transferred to the entire fluid by friction and vibrations: A current develops which can be regulated by changes in the voltage. The pump measures 5 x 5 mm and is 0.7 mm high. It transports 15 ml, i.e., the contents of a whiskey glass, per minute.

This process can only be used with electrically insulating fluids. Another pump version, also designed by IFT, is

more universal, i.e., also suitable for aqueous fluids: It consists of four silicon chips which are connected to each other. With the application of an electrical voltage, a membrane presses against the fluid and forces it out through a microvalve and vice versa. This pump measures 7 x 7 x 2 mm and transports a maximum of 79 microliters per minute.

Although silicon has been so well researched, it recently yielded another surprise for the researchers: It was possible to make silicon light up through application of an electrical voltage. Normal silicon behavior is such that it conveys radiant or electrical energy, which stimulates its electrons, in the form of heat, not light. More or less by accident, it was discovered that so-called nanocrystalline silicon begins to glow with the application of voltage. The nanocrystalline silicon is produced by etching with hydrofluoric acid. This creates innumerable minute pores in the material, which apparently alter the energy properties of the semiconductor. The exact mechanism has still not been completely researched. The lighting effect opens completely new prospects in silicon technology. It will make it possible to integrate optical components on a chip with another function, for example, in optical data transmission.

French Research in Thin Film Transistor LCDs Viewed

92WS0805A Stockholm NY TEKNIK in Swedish 13 Aug 92 pp 10-12

[Article by Ulla Karlsson: "His Microtubes Form Basis for Video Screen of the Future"—first paragraph is NY TEKNIK introduction]

[Text] In a laboratory outside Grenoble stands a 6-inch video display screen that is on 24 hours a day. Built from 70 million microtubes 2 mm thick and weighing 100 grams it is like nothing else. For this is the prototype of the video display screen of the future, a screen that combines the good aspects of the cathode ray tube and all the advantages of the crystal screen.

"When we began considering the use of microtubes for building a flat video display screen in 1986 no one believed it was possible. But we regarded it as a challenge and solved all the technical problems!"

These words were spoken by Robert Meyer. For the last six years he has headed the research group that was the first in the world to show that the technology of microscopic vacuum tubes can be used to build extremely thin video display screens. Screens that within three years after they go into production could be used in portable computers, cars and airplanes as well as instrument panels of all kinds. In the longer term they could be the perfect technical solution for the big screens required by the TV of the future, sharp TV. For this is an entirely new type of screen in which researchers have succeeded in combining the good properties of today's cathode ray screens and the advantages of liquid crystal screens.

The fact that Meyer and his 10-man research group decided to attempt to utilize the newly discovered microtube technology to develop a flat screen is no accident. In the mid-1980s a large group of researchers at their research laboratory, LETI, worked on developing flat screens from various types of liquid crystals. For example, LETI was the first laboratory to succeed in building a flat screen from ferroelectric liquid crystals, the type of crystal discovered at Chalmers Institute of Technology in 1979.

"But we also realized that it would be interesting to try to develop a flat screen of the emission type (which gives off light) and therefore we decided to start looking into the new microtube technology."

In the last three years the researchers have produced several hundred prototypes, prototypes they started showing in public about a year ago.

The prototype Meyer chose to display is undeniably impressive. Its response time is unquestionably as fast as that of an ordinary cathode ray screen or TV. We stood and watched the movie, "Bonnie and Clyde." The screen is incredibly thin, only 2 mm. That the 6-inch screen requires 70 million microtubes makes it no less remarkable.

However Meyer chose to emphasize another advantage over screens built with active matrices of liquid crystals (TFT-LCD), the technology that he regards as the biggest competitor:

"The large visual angle is probably the most important advantage. It is true that it has been improved in small LCD screens but it is still poor in larger screens.

"The response time is also much shorter. Microtubes have a response time of 1 microsecond, which makes it very easy to produce screens that can show TV. This response time can be retained even if the size of the screen is increased to 1 m^2."

He assigned only secondary importance to the screen's extreme thinness, a thinness that depends partly on the fact that the microtube screen does not require any background projection to provide good contrast.

The background projection in LCD screens also results in a higher power consumption.

"In our prototype the power consumption is only a fifth as much and this is when the picture is light. When it is dark the power consumption is even lower. Quite simply the power consumption depends on the content of the picture."

Both power consumption and thickness are important factors in portable apparatus applications. That the 6-inch thick prototype also weighs no more than 100 grams does not make it less attractive.

But 6-inch screens are not what the researchers had in mind for portable computers.

"We made the 6-inch prototype so we could study the technology and show that it works. Now our goal is to produce screens that are 10 to 12 inches in size."

Meyer said that such screens will be substantially cheaper to manufacture than screens with active matrices (TFT-LCD). That is the type of crystal screen that dominates the market for big flat screens today.

"Our screen requires only three photolithographic levels, for example. The corresponding figure for TFT screens is five to 10.

"Nor do we need any polarizer or background projection. The latter is an especially expensive part of the TFT technology."

But the TFT technology is also expensive for other reasons. Each image point on the screen is controlled by at least one transistor and a 12-inch color screen contains a million of them.

All these transistors must function in order to avoid white spots on the screen. This in turn means that the number of defect-free screens in manufacturing (the so-called yield) is often very low. Today the figure lies between 20 and 25 percent and as manufacturing costs are recovered on the defect-free screens the unit price is high.

The microtube technology is far less sensitive. The tubes are so small that there are 1,200 microtubes behind each image point.

We asked if the researchers have any problems at all with the new type of screen.

"Oh, yes, one problem is avoiding short circuits between the tip of a microtube (see sketch [not included]) and the gate. For if there is a short circuit the charge from the power unit does not get through and this produces a black line on the screen.

"But we are working on solving the problem by adding a resistive layer during production."

In the prototype Meyer showed us there were indeed a few small black lines across the picture.

This prototype operates in black and white, but color is required to be able to compete with cathode ray screens and crystal screens. However a technical solution (and a prototype) for a color screen already exist.

But before production of microtube screens can begin the researchers at LETI must find an industrial partner who can finance the remaining development before 10- to 12-inch screens can become a reality.

LETI is a state research laboratory, which means that the biggest sums go to basic research. The idea is that industry should pay for product development.

For example, the 6-inch prototype was produced when Thomson, the French electronics firm, was supporting the research. But the support came to an end two years ago when the company decided that progress toward big screens for sharp TV was too slow.

"Naturally we would prefer to find a new European partner, the only other alternative is the big Japanese interests that turn up here at regular intervals."

The situation is not new for the LETI researchers. The research on liquid crystal screens was discontinued in 1988 for the same reason; no European partner could be found. The technology was sold to Japan.

Meyer does not think things will necessarily be that bad this time:

"There is now an entirely different awareness in Europe and within the EC that flat screens are a strategically important product and that Japan cannot be allowed to take over all the technology in this area.

"There are also many indications that we will acquire a new European partner by the end of the year."

Graphics Captions

1. p. 10 (lower left): Microscopic volcanoes submerged in sheltering holes. That is how microtubes look when they are studied with a scanning electron microscope. The holes have a diameter of 1.4 micrometers. The dimensions are so small that a single square millimeter holds between 10,000 and 100,000 microtubes.

2. p. 11 (upper left): Seventy million tubes in one screen. With the new technique the electron gun in today's cathode ray screen is replaced by a matrix of microtubes. A sheet of glass is placed above the tube, leaving a space of 200 micrometers. The glass sheet has been coated with a material that acts as an anode. On the anode is a layer of phosphorus. There is a vacuum between the upper and lower sheets of glass.

When an electric field is applied between the gate and the cathode the electrons rush out through the microtip toward the anode and strike the phosphorescent layer. The point hit by the electrons lights up.

3. p 11 (upper right): The production of microtubes involves six main steps from coating the glass sheet with thin film to etching away superfluous metal.

A. The initial material in the production of microtubes is a sheet of glass that is coated with three layers using the thin film technique: one that acts as a cathode, an insulating layer (silicon dioxide) and a layer of metal (the gate).

B. A matrix of holes is etched in the metal film. Each hole has a diameter of 1.4 micrometers.

C. Cavities in the insulating layer are etched chemically through the holes.

D. With the help of electron beam epitaxy a layer of nickel is vaporized on top of the metal film.

E. Molybdenum in vaporized form is now forced in through the partially closed hole. The size of the hole is reduced as the molybdenum is deposited on the edges. The result is that a cone or microvolcano is built up inside the cavity. The base of the cone is 1.4 micrometers while the tip is only a few atoms wide.

F. Finally the layers of molybdenum and nickel are etched away. The result is a microtube.

NUCLEAR R&D

German Research Minister Approves Construction of BESSY II Synchrotron

92MI0676 Bonn TECHNOLOGIE-NACHRICHTEN MANAGEMENT-INFORMATIONEN in German 10 Jul 92 pp 6-7

[Text] Construction of the new synchrotron radiation source (BESSY II) in Adlershof, Berlin, has been approved by Federal Research Minister Riesenhuber on the basis of the 1993 budget and the 1994-1996 medium-term financial plan. A major factor in the decision in favor of BESSY II is its intended location in the Adlershof district of Berlin, where BESSY II will contribute significantly to the redevelopment of the former Academy of Sciences site into a science and technology center, and thus to research and development in the new laender. The construction of BESSY II there represents a striking, and directly effective, landmark in research policy.

The Berlin Senate has promised to contribute 50 percent of the building and operating costs of BESSY II; the project would certainly not have been viable without this commitment by the Land of Berlin. Application will be made for inclusion of BESSY II in the Blue List.

The BMFT's [Federal Ministry of Research and Technology] decision in favor of BESSY II followed the recommendation of the Basic Research Commission, which gave BESSY II a high priority rating. The BMFT has no further plans at present for funding large-scale facilities for basic physics research, though it will in due course contribute a fixed sum agreed some time ago towards a research reactor in Munich planned by Bavaria.

BESSY II: Factual Data

The Berlin Electron Storage Ring Company for Synchrotron Radiation mbH [Limited] (BESSY) was established in 1979 as a nonprofit research facility

Partners	Max Planck Society	AEG Telefunken
	Fraunhofer Society	Eurosil GmbH
	Hahn-Meitner Institute GmbH	Philips GmbH
	DESY [German Electron Synchrotron]	Siemens AG
Purpose	To build, operate, and develop an electron storage ring as a synchrotron radiation source; to commission BESSY I ring in 1981	
BESSY I Storage Ring	Location	Wimersdorf, Berlin
	Power	800 MeV
	Electron flux	0.5 A
	Circumference	62.4 m
	Spectral region	0.4-200 nm; VUV & weak X-ray region
	Annual radiation time	>3,000 hrs.
	Injector	Synchrotron 800 MeV
	Preaccelerator	20-MeV nonquantized microtron
	Annual budget	DM15 million
	Employees	67
	BESSY I provides experimental facilities at 34 measuring stations with 25 monochromators and two undulators, used annually by over 500 scientists in around 130 teams from over 20 countries	
BESSY II Storage Ring	Location	Adlershof, Berlin
	Power	1.7 GeV
	Electron flux	0.1 A
	Circumference	194.4m
	Spectral region	0.04-200 nm; VUV & weak X-ray region
	Injector	Synchrotron 1.7 GeV
	Preaccelerator	50-MeV racetrack microtron

BESSY II: Factual Data (Continued)

	Brilliance Improvement over BESSY I	1,000-10,000
	Project Costs	DM190 million (taking account of inflation)
	Operational from	1997
	Annual budget	DM20 million (at 1991 prices)
	Employees	85
	On completion, BESSY II will have at least 16 undulators and wigglers, and around 45 diplo beam holes.	

SUPERCONDUCTIVITY

British Firm Develops New Metal Oxide Superconductor

92WS0792A Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 21 Jul 92 p 8

[Article by toz.: "Ceramic Superconductor at 92 Kelvin"]]

[Text] Frankfurt—The search for additional high-temperature superconducting materials continues: After intensive, computer-supported research British General Electric-Marconi in Wembley (Middlesex) has discovered a new metal oxide compound. It consists of cadmium, lead and copper oxide and has a critical temperature of 92 Kelvin, corresponding to -181°C.

The temperature differential to the evaporation point of nitrogen at 77 Kelvin (-196°C) is 15 temperature degrees and is thus sufficiently large enough to enable numerous technical applications even at high currents. According to the first materials tests this new superconducting material is less fragile than the calcium-, bismuth- and strontium-containing high-temperature superconductors and could therefore be more suitable than those or similarly constructed ceramics for the manufacture of wires or cables in power engineering.

The company developed a computer program to specifically search for the new compound, a program that controlled a robot which synthesized the material samples to be tested. Over a period of more than two years in excess of 15,000 material combinations were thus examined with respect to their superconductivity above 77 Kelvin.

The company received financial support for its development work within the framework of an EC research program. Patents have now been applied for in several countries for the new material blend and two other similarly promising mixtures, reports the Hirst Research Centre (GEC Narconi, Wembley, Middlesex, HA9 7PP, United Kingdom).

TELECOMMUNICATIONS

Siemens Subsidiary To Increase Glass Fiber Cable Production

92WS0629C Munich COMPUTERWOCHE in German 5 Jun 92 p 19

[Text] By investing over DM60 million, Siecor GmbH, a joint daughter company of Siemens AG and the U.S. company Corning Inc., hopes to double its production capacity to a million km of glass cable per annum. According to Siemens, the company, which regards itself as the second largest producer of glass cable in Europe, had reached the limits of its capacity because of the unexpectedly high demand. In the previous business year DM95 million in sales had been achieved with a work force of 270.

The company estimates that the market volume will expand significantly in the next five years and will grow to 13.5 million km per annum worldwide by 1996. They say that the demand for glass cable grew from 2 million to 7 million km from 1986 to 1991. In professional circles Germany is regarded as the most rapidly expanding market for glass cable, because Telekom plans to install light wave conductors for subscribers even in local telephone networks.

French CNET Develops Universal Cordless Communications

92BR0688 Paris FTS in French May-Jun 92 p 5

[Text] The RAMEAU [Advanced Network for Universal Mobility and Access] project of the CNET [National Center for Telecommunications Research] was launched on 15 November 1991. It involves several teams from various CNET centers: Paris-A (services, protocols, and networks), Paris-B (terrestrial and satellite radio transmission), Lannion-A (services and speech coding), and SEPT [Post and Telecommunications Joint Study Center] (services). The project aims to develop the technology and to draw up the specifications for a universal cordless personal communications system to be put into service around the year 2000.

Development of the GSM [Special Mobile Group] cellular mobile phone system and the "phone point" type of cordless telephone mark a first step toward universal cordless personal communications. In future, cordless telecommunications networks will need to allow people to communicate regardless of where they live or where

they travel and to provide them with a wide variety of high-quality services with high traffic capacity, similar to the wire-based systems such as RTC [switched telephone networks] and ISDN [integrated services digital networks].

A universal cordless personal communications system needs to combine following characteristics:

—Use of frequency bands between 1 and 3 GHz;

—A multi-environment terrestrial system (on the street, at home, in the office, or in a vehicle), incorporating as much as possible the technology used in cellular mobile telephone systems, cordless telephones, and satellite transmissions;

—A multi-service system (speech, paging, data, fixed and moving pictures) whose services are compatible with those provided through wire-based systems;

—High traffic capability comparable with that of wire-based systems;

—Support of universal personal communications services and implementation of mobile services that are coherent with those of wire-based systems (a universal personal number).

Completion of the RAMEAU project will take five years and will involve industry for producing feasibility models. The initial three-year phase will be devoted to basic research needed for designing the system. The second phase will involve the construction of one or more models to demonstrate the technical feasibility of the system. Through this project, the CNET will participate in the European RACE II [Research and Development in Advanced Communications Technologies in Europe] research program on the Universal Mobile Telecommunications System (UMTS). This program began in January 1992 and will last for three years.

The results of the RAMEAU project are expected to contribute to the work of various organizations which started up research programs with comparable technical goals: the ETSI [European Telecommunications Standards Institute] with the UMTS; and the CCIR [International Radio Broadcasting Consultative Committee] and CCITT [Consultative Committee of International Telephone and Telegraph] with the Future Public Land Mobile Telecommunications System (FPLMTS). The sector of mobile communications is expected to be one of the main lines of development of telecommunications technology in the coming years, focusing efforts on research and design.

France: Alcatel Director Assesses Mobile Communications Strategy

92WS0692N London PAN-EUROPEAN MOBILE COMMUNICATIONS in English 1992 pp 22, 26, 28

[Alcatel has not to date been a major player in mobile. But the company is planning to utilise its expertise in digital communications to become a dominant force in GSM—without neglecting other areas of mobile communications, Jacques Imbert, President of Alcatel's RSD group, reveals his plans and strategy to Paul Chambers]

[Text] When Jacques Imbert embarked on his career as an engineer with the ITT group, he would probably not have imagined finding himself one day in charge of a key division at Europe's largest equipment maker. He might not have believed you either if you had predicted how important mobile communications were destined to become.

In those pre-Alcatel days, there was no mobile communications industry as we know it today. Since then, the application of radio technology has brought a host of new possibilities. Today, to coin a phrase, almost all roads seem to lead into the mobile arena and Alcatel is determined to lead the way in the search for the potentially rich rewards.

Imbert, the president of Alcatel's Radio, Space and Defence Systems (RSD) group, admits that the company has not to date been a household name in mobile communications. Others have been taking the lion's share of analogue cellular markets. Although it has not taken centre stage yet, Alcatel has been quietly awaiting the moment to play its ace card.

Digital Technology

That card is expertise in digital technology. As Imbert and colleague Henri Hubert, president of Alcatel Radio-Telephone, explain, it was the digitalisation of public switching that propelled Alcatel to the front of the field. Only last year, the company claimed the number one spot from U.S. giant AT&T.

Now they believe history is about to repeat itself. With the implementation of GSM [Global System for Mobile Communications] pan-European digital cellular, Alcatel is getting an opportunity to play its ace card for the second time.

Not surprising, therefore, that Imbert and Hubert speak with enthusiasm about Alcatel's products in the field. It is as if fate is on their side. Not only does GSM need expertise in digital communications, it is also a standard being implemented in Europe, Alcatel's own back yard.

So confident is Imbert in Alcatel's future in GSM that he is prepared for the company to go it alone in its bid for leadership.

The company had formed an alliance with Nokla and Germany's AEG three years ago. The three had agreed to work together on the development of GSM radio infrastructure. But Imbert says this agreement will not be continued for work on second generation equipment. "Partnership in this technology is difficult to implement because the interests of companies are different," he says.

Acquisitions

In Imbert's opinion, "acquisition or real merger is more efficient." While the Nokla AEG alliance has been running, therefore, Alcatel has been working behind the scenes to reinforce its position by acquiring the U.S. company Rockwell and the Italian company Telettra. Acquisitions which, according to Imbert, have strengthened its hand for the GSM assault in two ways.

First, the Telettra acquisition has boosted Alcatel's financial resources. This is an important factor considering that GSM research and development work is estimated to cost five times more than work on analogue systems. In 1990, prior to the merger, RSD was generating ECU1.3 billion in sales. Following the acquisition, approved by the European Commission in March 1991, it is expected to generate ECU2.1 billion.

And Alcatel has moved to boost revenue from the microwave sector. Before the acquisition of Rockwell, it had 12 percent of the world market to NEC's 24 percent. Following the acquisition, it has 31 percent of the world microwave market, with NEC still where it was before.

Overall, these moves have enhanced Alcatel's financial position enough for it to be able to commit ECU100 million annually to GSM research and development without adversely affecting its overall balance sheet, says Imbert.

But the acquisition promise to lever Alcatel's efforts on GSM in another way, by adding new people to its pool of skilled engineers. Human resources are vital, says Imbert, in a sector like GSM where a company has to bring out a new generation of equipment every 18 months.

Imbert does not rule out further acquisitions in future though he says moves to date are "enough" for the moment.

But he says the risks involved in trying to exploit GSM are such that some companies are bound to find it difficult. On the one hand the market could develop faster than predicted. On the other it could develop slower.

Without naming names, Imbert says the map of Europe's mobile communications will not be the same in five years time as it is today. But he is implicitly confident that Alcatel will still be there because size is one of the factors which will count the most. "Only very big groups will remain," he says.

So acquisition is one string on the Alcatel bow. Another is its existing strength in depth, Imbert argues. He notes that all the specialisms of his group—satellite earth stations, military and civil communications equipment—require and breed expertise and generate experience which can be turned to profit in the battles that lie ahead.

Strengths

With such support behind it, Alcatel's RSD division will be mounting its GSM assault with a full range of equipment: terminals, base stations and switches. And with production about to get underway, Imbert says he sees four specific Alcatel strengths.

First, it has been working on a proprietary Application Specific Integrated Chip (ASIC) set since 1988. The company believes having its own chips to be a vital card. Without them, it would be difficult to move ahead now as no standard chip set is available from an outside source.

Second, it has decided on a bold production strategy. Risks are no excuse for hesitation in Imbert's book and as long ago as 1991, the decision was taken to build a factory in France (at Laval, half way between Paris and Rennes). By 1995, says Imbert, this factory will be making 500,000 GSM terminals a year.

It is a move based on two premises, he explains. Manpower represents only 8 percent of manufacturing costs for GSM terminals. So there is nothing to be gained by locating production where manpower costs are low. And with new generation equipment appearing every 18 months, it is vital to have Research and Development and production functions close to one another.

Third, Alcatel will be setting up new distribution structures. Imbert says there will be a new service providing a company to handle subscribers for France's two GSM networks. And Hubert anticipates that GSM terminals will be marketed and sold through organisations with large distribution networks such as petrol stations.

The day will also come in the not too distant future, he predicts, when a mobile telephone will become a standard option in a car rather like the car radio is today. There will be no need for special installation.

The fourth element in Alcatel's GSM strategy is potentially the most powerful. It has conceived its system to be built on its digital switches. After all, as Imbert says, mobile communications is "an extension of public switching." The mobile switching centre and base station controller, for example, both use existing switches as a platform.

This gives the company high hopes that the international presence of its switches will tell. It has already got orders for its infrastructure from a number of countries worldwide. Purchasers include Telecom Australia, the Austrian PTT, France Telecom and its competitor, Societe Francaise de Radiotelephonie, Deutsche Bunderspost Telekom, SIP, the Italian operator, PTT Telecom Netherlands and Telefonica in Spain.

And the same strategy will see Alcatel moving into the growth markets of Eastern Europe by the middle of this decade, Imbert says. At that point, he predicts, eastern European countries will be moving out of the first phase and into the second phase of network development.

At the moment, he says, "Eastern European countries are looking for a way to close gaps in their basic telecommunications infrastructure." Whereas this means good opportunities for makers of analogue systems, the opening for companies like Alcatel, whose strength is in digital, will come later.

Imbert says Alcatel is already strongly present in eastern European countries in digital switching. The hope is that the existing supplier/customer relationship and the reputation of the switches will pay dividends when the transition to digital comes.

All this effort on GSM is understandable considering the size of the potential market for digital cellular. Experts are predicting a market of 20 million terminals by the year 2000, Imbert says. With Europe's population currently some 350 million, that means penetration of 8 percent.

Imbert and Hubert predict that when GSM start-up finally comes ("Mass delivery of terminals will begin in the second half of 1992 and in 1993"), the market will boom quickly. Two years ago the company was thinking in terms of earlier start up (1991) and slow growth. Now start-up will come later, but the growth curve will be much sharper.

Hubert says the delays caused by the need to debug the "very complex" software actually represent a plus in the final equation. All the time, the roll out of infrastructure is continuing so that, by the time the software is debugged, coverage will actually be better than it would have been if launch had been on time.

Mass Market

Imbert foresees that digital cellular systems could become true mass market products by the end of the century. GSM, as a standard system promises to recruit subscribers in large numbers. And application of new Personal Communications Network standards could see cell densities of 10 to 12 times what is possible with the GSM derivative DCS1800 currently being applied for PCNs in the UK.

With higher cell density will come lower powered, lighter handsets. But for a real mass market to grow, Hubert says the price of the total communications package (terminal, amortisation of the terminal and the cost of usage) must come down to under Fr4400.

Mobile Communications

Naturally, GSM does tend to hold centre stage in a conversation with Imbert. But Alcatel is not neglecting other areas in mobile communications. As he himself told a recent press seminar in Rome: "We want to be present in the whole mobile communications field."

Take the DECT [Digital European Cordless Telephone] standard, for example. "DECT complements what we are doing in GSM," Imbert told journalists in Rome. And he told PAN-EUROPEAN MOBILE COMMUNICATIONS the company is "working hard on the area."

"There is some overlap," he said, "but the two markets are very different." But he said he foresaw that toward 2010, GSM and DECT could merge in a Universal Mobile Telecommunications System (UMTS). This would enable the user to access all kinds of mobile communication networks from one terminal.

Private Mobile Radio is another area which Imbert characterises as "very important" for Alcatel. The company is claiming 10 percent of the European market following the acquisition of Telettra. And it is supporting work by ETSI [European Telecommunications Standards Institute] on a future standard for Digital Trunked Mobile Radio (MDTRS [Mobile Digital Trunked Radio Standard]). Not the least because work done on MDTRS can benefit work being done on GSM. Once again, the Alcatel approach is to seek out and exploit synergies.

Alcatel is also venturing into what could be its most ambitious project. In a joint venture with the U.S.'s Qualcomm, it is seeking to set up a system called Globalstar to link mobiles out of reach of terrestrial cellular networks with the public switched telephone network. There could be 24 low earth orbiting satellites by 1997 to cover latitudes 30° to 50°.

Imbert is not dismayed by recent bold marketing moves by Iridium, a Motorola subsidiary which is promoting a rival system. At a recent press conference, Iridium announced it would be leasing capacity on its system to rival Inmarsat (planning a system called Project 21). It also announced that its handset would use GSM derived technology, giving it the ability to interface with GSM networks.

"It will be an interesting competition," says Imbert. "There are many other systems and we are far from the final decision. There are lots of combinations that could be made."

Whatever happens with such futuristic systems, Imbert is clear on one thing. Whereas at the outset of his career, the attention of young engineers like himself was focussed more than anything on the fixed network, now mobile communications engages almost as much, if not more attention. He foresees the day when mobile communications networks will offer as many features to the user as fixed networks do today.

German Mobile Communications Market Assessed

92WS0692O London PAN-EUROPEAN MOBILE COMMUNICATIONS in English 1992
pp 30, 32, 36, 38

[Article by Herbert Grab; first paragraph PAN-EUROPEAN MOBILE COMMUNICATIONS comment]

[Text] The official launch of the digital mobile network in Germany has been delayed for a few months because of a lack of terminals—caused by problems with the type approvals process. In April the waiting should finally be over.

Peter Mihatsch is not to be envied. At the Telecom show in Geneva last autumn, market observers reckoned that his company Mannesmann Mobilfunk (MMO), which operates the first private mobile phone network, is spending 1 million German marks [DM] per day—without any revenue. Nothing has changed since Mihatsch invested approximately DM140 million in the development of the D2 network and MMO has almost 1,000 employees.

And the figures for D1 manager Hans Kerier at network operator Deutsche Bundespost Telekom are not too different. Both emphasize that the development of their networks is on schedule—coverage includes all major centres and their interconnections, reaching almost 75 percent of the population.

But even the finest networks won't work without handsets. These are not yet available because the hardware and software for type approvals is not complete and ready for use. The reasons for the delay are complicated.

Mobile Network Subscribers in Germany
As of 1 January 1992

B-Netz	14,387
C-Netz	532,251
Eurosignal paging service	210,281
Cityruf paging service	132,015
Tone only	69,513
Numeric	37,810
Alphanumeric	24,692
Source: Deutsche Bunderspost Telekom	

One reason is the complexity of the European GSM standard, with some details still needing to be defined and confirmed. Another reason is the technical and administrative complexity of the approval process. Every single step has to be approved by a European committee because, in the interests of transborder communication, future licences should not be limited to national networks.

The third reason is that the manufacturers did not take sufficient account of the magnitude of the work involved with the digital equipment. They only started to get their equipment ready in the last few months after details of standards and test procedures became available.

But time presses. Not only because of the economic difficulties the network operators and future service providers may suffer but also because the existing analogue C-network is becoming saturated. While nothing is yet working on the digital side, the analogue system is booming. Subscriber numbers have more than doubled in the past year. There were 554,000 subscribers at the end of January 1992—an increase of around 24,000 in January alone!

Ten Million Subscribers by the Year 2000 [Boxed Item]

"Deutsche Bundespost Telekom expects around 10 million subscribers to mobile radio services in Germany by the year 2000," said Dieter Gallist, member of the board at DBP Telekom, at a press conference in Berlin. DBP Telekom also reckons on a market share of about 3.7 million subscribers to their mobile networks.

Gallist emphasizes that the development of the paging services City Call and Eurosignal is as positive as C-Netz. On 1 January 1992, after only three years of existence, DBP Telekom had over 132,000 City Call subscribers—an increase of almost 100 percent on 1991. Eurosignal now has more than 210,000 subscribers. [End boxed item]

If this increase continues at the same rate, the capacity of the analogue network—between 750,000 and 800,000 subscribers—will be reached within a few months. Although last year the capacity was around 600,000 subscribers, DBP Telekom reduced channel widths to satisfy demand at least until the introduction of the new D-network. This became especially necessary because of the obsolete telephone network in the new counties of the former East Germany, where politicians and business people were forced to use the C-mobilephone network as the only way of obtaining a decent telephone connection.

But the end of digital 'starvation' can be foreseen. Although they will not be in time for the CeBit fair in Hannover, as was still widely expected in December, the first Europe-wide approved GSM phones will leave the central department for telecommunications approvals (ZZF) and the Rhine Westphalian TUEV in Essen in April.

The commercial GSM market in Germany is expected to start around the middle of the year. It is also expected that dealers will migrate rapidly from analogue to digital equipment.

The first manufacturers offering approved GSM telephones in the German market will include Siemens, Motorola, Nokla, Panasonic and Orbitel, a subsidiary of the British Racal Telecom and the Swedish LM Ericsson. Other companies such as Bosch, Blaupunkt, AEG, Hagenuk, Dantronic, Philips, Ericsson and Alcatel SEL will follow suit.

The main question is not when individual manufacturers will be able to produce their equipment in quantity but when the testing institutions will complete their procedures. Each set of approvals tests takes three to four weeks and causes a bottleneck which will complicate the launch of the GSM market for a few months.

Cordless Phones—Simple and Sought After [Boxed Item]

The demand for cordless telephones in Germany is increasing. After two years of stagnating sales—100,000 sets were sold in 1990 and 1991—market leader Hagenuk expects an increasing rate of sales and are predicting that over 150,000 cordless phones will be sold in Germany in 1992. This means that by the end of 1992 almost 600,000 terminals will be in active use.

The main reason for this strong growth is that at least every other cordless telephone is now bought by a private household—the threshold into the private sector, and so into the mass market, has finally been crossed. Cordless phones have become a symbol of lifestyle. [End boxed item]

But there is one advantage to this delay. As the manufacturers of digital mobile phones have had time to prepare for the launch there should be no difficulties in supply. They have confirmed there will be no problems supplying large quantities. And considering the continuing boom this could well be necessary. Last September, DBP Telekom ordered 28,000 mobile phones—15,000 from Siemens, 2,000 from Orbitel and 11,000 from Motorola. Initial contracts of a similar size from Mannesmann were placed with Siemens and Motorola last autumn, as well as with Nokla, the Finnish manufacturer for D2.

More good news for suppliers is that the 13 service providers seeking to earn money in the German digital mobile phone market will need numerous mobile phones from different manufacturers.

But the prices don't give cause for optimism. In the opinion of a salesman, margins are likely to be too low to allow decent competition. In the interests of a quick and strong start, MMO director Mihatsch had mentioned figures last summer. Low ones unfortunately. MMO wants to sell its cheapest mobile for only 2,495 German marks [DM].

As a portable with a car-mounting kit, the same terminal should cost DM2,950. These prices include VAT but no aerial or installation costs. For this price not even a manufacturer such as Motorola would give away its terminals. Gritting their teeth, manufacturers listened to the words of the MMO boss and adjusted their plans accordingly. Most of them will go along with D1 director Hans Kerler who will offer digital mobile phones for prices in the range of DM3,000 to 3,500 plus VAT. But certainly there will be some who break through the price barrier of DM3,000.

"Because of the small volumes, such low prices do cause pain to all manufacturers," says Kalevl Kaartinen, managing director of Nokla mobile phones in Germany. Nobody starts with a positive financial position. They are all hoping for rapid growth because then even MMO's low prices won't cause a problem.

Still to be observed are developments at AEG, in particular whether they can hold prices for their CD series terminals which lie between DM5,299 and 6,758, and whether Alcatel SEL's price list for GSM telephones, which started at DM3,573 and ended at DM4,070, will be adjusted.

The new GSM telephones will not be much smaller in size than their analogue predecessors. Models available at the beginning will either be mobiles for installation in cars, portables or transportables. Their weight will be between 2.0 and 2.7 kg.

PCN in Germany; DCS 1800 Licence To Be Issued [Boxed Item]

There will be a third licence for digital cellular mobile telephony in Germany following a recent decision by the minister of Post and Telecommunications, Dr. Christian Schwarz-Schilling.

The third provider will be in addition to Mannesmann Mobilfunk and Deutsche Bundespost Telekom, who are presently building up their GSM networks. The new licence will allow the building of a nationwide network for PCN using the DCS 1800 standard. The licensing conditions will be published in March.

To guarantee the provider a fair start, the current providers of D-Netz—Mannesmann Mobilfunk and DBP Telekom—will not be allocated frequencies in the region of 1.6 GHz for the first four years, preventing them from participating in PCN during this period. [End boxed item]

By next year—autumn at the earliest—small handsets will be on the market. The only exception being Hagenuk of Kiel which is producing a hand-portable christened MT 900 right from the beginning. D. Duennieder, sales manager at Nokla explains: "We will not get onto the market with hand-portables until the networks and the software have stabilised, probably in early 1993."

Transportables which can be either installed or carried around will not be offered at all by Nokla. Their experience in other mobile phone markets is that the demand for such terminals decreases soon after the stabilisation of the market.

Trunked Mobile Radio in Germany; Limited Interest [Boxed Item]

At the beginning of May 1992, the Ministry of Post and Telecommunications (BMPT) in Bonn will allocate the remaining 22 licences for private mobile radio in German. Six licences were issued in April 1991.

Apart from the 'Chekker' system, currently being established by DBP Telekom, there will only be a few providers running private mobile radio networks in Germany. PMR is offered as a commercial service to taxi companies, shipping companies and others working on a regional basis. The decision on who will be allowed to run these networks will be made at the beginning of May.

By the qualifying date of 2 December 1991, companies had confirmed their interest in acquiring one or more radio licences at BMPT in Bonn.

Altogether there are 28 'A' licences available in 14 areas, two for each area. To guarantee competition, providers can only get one licence per area. In April 1991 four radio operators were granted six 'A' licences. Quickfunk (a subsidiary of Mannesmann, Klenzie and Motorola) were allocated three licences; Preussag radio, Primus radio and MobilKom Berlin received one each.

They have all built up their networks by now and official service will start within a matter of weeks. Quickfunk, Preussag and Primus have applied for 'A' licences again together with a few large energy utilities and other substantial organisations.

These include D.B.F. radio (a subsidiary of Quante AG Wuppertal and Berotronika Berlin), Rheinelsktra, Thuefunk (a subsidiary of Bayemwerke and three new energy utilities in Thueringen—ENAG, OTEV and SEAG).

Many of the companies allocated an 'A' licence are applying for 'B' licences as well. These licences—for areas of low population density—are given away more easily than 'A' licences. The procedure involves a simple application rather than a competitive process.

The advantage for PMR operators with 'A' licences is either to extend their coverage area with 'B' licences or to interconnect two 'A' licence areas. [End boxed item]

There is one big disadvantage of the move to digital networks that all manufacturers would like to conceal. Every single terminal approved this year will have to go back to the factory at least once for exchange of updating of its software. The reason is Reduced Interim Type Approval (RITA) which represents a nuisance for the whole industry.

RITA was born out of trouble. The bodies responsible for European-wide approvals lowered their standards for GSM terminals several times last year in order not to postpone the launch further. They invented the interim Type Approval (ITA) to reduce their demands again. And the terminals only have to meet these standards.

The consequences are that as soon as the testing bodies are able to operate according to the interim approvals they will do so. But if the owner of a GSM terminal wants to own and use the actual software he will have to return to the factory—and again next year when the Final Type Approval (FTA) comes up.

The only comfort is that manufacturers and service providers will not pass these costs onto the customer.

Germany: Six Telecommunications Satellites To Be Deployed for Worldwide Broadcasts

92WS0700A Duesseldorf VDI NACHRICHTEN in German 12 Jun 92 p 25

[Article by Egon Schmidt: "Helper in Orbit"]

[Text]

The Loneliness of Polar Researchers May Soon Be at an End. Six Small Satellites Will Soon Establish Contact With Civilization, Even in the Eternal Ice

Munich Satellites Can Transmit Communications Services Even Worldwide

Life in polar latitudes is not characterized by communications. In the icy expanses, separation can often have fatal consequences. There is no possibility of calling for help for difficult problems. Expeditions have had to experience this time and again. Polar researchers who have become gray in honor, for example, tell of emergency appendicitis operations in the open at -20°C. Then there was the group of three scientists caught by accident on a separating ice floe.

In times where worldwide direct transmission of television reports has almost become routine, it is hard to believe. "In the Antarctic, there is often no possibility of communications when accidents occur," says Dr. Niko Balteas from Kayser-Threde, a technology systems house in Munich. The only usable technology there is shortwave radio. However, these radios often break down or cannot be used for physical reasons over distances of 200 to 600 km. Besides, they are so bulky that they are very difficult to carry.

However, the speechlessness and helplessness of the researchers will soon be part of the past. Dr. Heinz Kohnen from the Alfred Wegener Institute for Polar and Ocean Research in Bremerhaven and the Kayser-Threde Company suggest a satellite system so that helpers can be alarmed in emergencies. This system would be inexpensive to set up and could be expanded again in steps. It is based on the experiences coming from a successful preliminary experiment done with the Tub-Sat-A of the Technical University of Berlin. As a start, it foresees installation of a total of six small communications satellites in a polar orbit at an altitude of 1200 to 1600 kilometers.

These satellites would orbit the earth from pole to pole every 100 to 110 minutes. They would follow one another at equal distances. For polar researchers, this would mean that they would have at least one of these satellites in their field of view at all times. In this way, they could make voice contact directly with the artificial moon. In this respect, the satellite acts as an information carrier and bears the message, perhaps, to the Georg-von-Neumayer Research Station, to the Polarstern research ship, or even to Bremerhaven. The satellites can also communicate with each other. They could transmit operational data during everyday use. The satellites

could also send telecontrol commands to isolated, unmanned research stations somewhere in the Arctic. They could contact the partially remote-controlled computer on the Polarstern.

One prominent feature of this communications concept is "that a simple hand-held radio with about 5 W power output costing 700 German marks would suffice for emergency voice contact with the satellite," explains Balteas. In theory, even one of these satellites would be adequate, thanks to the polar orbit, to contact the satellite briefly at certain intervals from any point on the earth. Then, talking to other stations also 'seeing' the satellite at the same moment would be possible. As the earth rotates away, in a certain sense, beneath the polar orbit that is fixed in space, one single satellite flies over every point on the earth again at specific times. Because of this, a communications system that can be used worldwide may become reality.

Just six satellites, all orbiting in the same polar orbit, would ensure that at least the polar areas are covered at all times. Besides, every other point on the earth could be contacted for at least 90 minutes in intervals of 12 hours. If polar orbits, offset from one another by 120°, have six satellites each, 18 satellites would be sufficient according to this concept, to reach any point on the earth continuously. In this way, the proposal from Bremerhaven and Munich competes with the well-known communications satellite project Iridium from the U.S. company Motorola.

The individual satellite systems from Kayser-Threde are to work in the two-meter band, at about 150 MHz. These systems "are to be tested operationally" on the Russian Meteor mission in August 1993 with the help of the Tub-Sat-B satellite. Frequencies in the two-meter band recently became free. This was dictated in March of this year at the international radio administrative conference WARC '92 in Spain. "However, there are legal obstacles in Europe because of the traditional post-office monopoly. In the U.S. and in Australia, on the other hand, anyone can set up communications systems of this type by simply licensing them," complains Balteas.

Kayser-Threde proposes launching the satellite with Russian rockets. This means of transport is particularly inexpensive because of the special orbits. To place one satellite in orbit would cost only 3 to 4 million German marks [DM]. Accordingly, a complete 18-satellite installation would cost not quite DM70 million. However, Balteas's company does not want to set up and operate a satellite system itself. Rather, they always want to cooperate with partners, such as the polar researchers now.

According to its own claims, Kayser-Threde is a company with about 170 employees, making sales of about DM40 million annually and having annual growth rates of 10 to 15 percent. The company was founded in 1968 and includes, since then, an affiliated company in Italy and its own office in Moscow. This office contributes about DM15 million of revenue. According to Balteas, the company from Munich made substantial contributions to the spectacular Mir 92 mission. This mission carried the astronaut Klaus Dietrich Flade last March to the Russian space station Mir with an expenditure totalling about DM40 million.

France Telecom Launches Itineris Mobile Phone

92WS0703D Paris AFP SCIENCES in French
18 Jun 92 pp 13, 14

[Unattributed article: "New GSM Digital Radiotelephone Service Available 1 July"]

[Text] Paris—On 1 July in Paris and Lyon, France Telecom will begin implementation of the new GSM [Global System for Mobile Communications] European digital radiotelephone service announced on 11 June by the public telephone company's president, Mr. Marcel Roulet.

Marketed under the name of Itineris, this digital cellular telephone system is primarily intended for car telephones and will eventually allow calls to 18 countries, thanks to the adoption of a single standard, GSM. By the end of the year, this network should cover the Lille-Paris-Lyon-Marseille-Nice axis. By the end of 1993, all the major cities and the routes connecting them will be covered. France Telecom plans to make Itineris accessible to 90 percent of the French population by 1995.

For the public telephone company, this means a 4.5 billion French franc [Fr] investment in infrastructure and the installation of 300 to 400 radio transmitters in France over the next three years.

The advantages of this system over the current analog car telephone networks (Radiocom 2000 and SFR [French Mobile Telephone Company]) lie in the services offered by digital technology, European interoperability, and the terminals themselves. The telephone number will now be encoded in a smart card (manufactured for Itineris by Gemplus) instead of the terminal. Each subscriber will have a card, protected by a personal code, that contains complete information on the service to which he subscribes (European France, Europe, call forwarding, etc.). When he inserts his card in the terminal, it becomes his telephone. Calls will be billed monthly.

The terminals currently available are portable sets weighing around 2 kg and costing approximately Fr10,000. Orbitel, Nokia, and Motorola have received intermediate approval. The French groups Alcatel and MATRA, which have already been chosen to provide the infrastructure, should follow. Smaller terminals should be ready by fall at a price of about Fr15,000. "European economies of scale should cut the price of a terminal in half in five years," Mr. Roulet said.

In addition to listening comfort and the confidentiality of communications, digital technology will offer a wider variety of services, including call forwarding, facsimile,

and possibly data transmission. Also, under the agreements between the European companies, it will be possible to call from or to other countries with the same card.

Currently, around 400,000 people in France subscribe to conventional car telephone service via Radiocom 2000 (France Telecom) or its private competitor SFR (94,000 subscribers). Since mobile communications are in the public sector, SFR, an affiliate of Generale des Eaux, should also be launching its own GSM network service in France in the near future.

Public Operators Launch All-Digital Global European Network

92WS0706E Chichester INTERNATIONAL TELECOMMUNICATIONS INTELLIGENCE in English 13 Jul 92 p 1

[Article: "Part-Shared Infrastructure for Five Operators"]

[Text] Last week, Europe's five largest public telecommunications operators joined together to launch the Global European Network, a new, shared infrastructure that the companies concerned will use to offer leased line capacity to private customers in those five countries. Founder members or constructors—although little infrastructure construction is actually needed—are BT, France Telecom, Deutsche Bundespost Telekom, ASST/STET and Telefonica.

Essentially, the operators are pooling part of their existing transmission, fibre optic cable and digital switching network infrastructures to enable each of them to offer faster provisioning times for leased lines. A BT spokesman said that most of the infrastructure equipment is already in place, forming part of each operator's national and international networks presently. Other infrastructure may be needed to expand capacity and provide route diversity but this is not yet the case. Reserved capacity already exists to allow for network failure.

The shared elements of the network will be controlled from two network management centres, with one based in the UK and the other based in France, although each operator will have the means of supervising, restoring and reconfiguring services and capacity on its own "European subnetwork," as France Telecom has elected to call them.

Services on the "new" network will be available from the beginning of 1993, current plans envisage. There are no regulatory hurdles to be overcome, since the agreement covers only the provision of a "shared infrastructure resource" and does not include any element of collusion regarding the provision of services. Indeed, the European Commission was told informally that the companies were about to announce the launch of the network and membership invitations are due to be extended to all other major European operators. As the BT spokesman said, when asked if Mercury Communications would be invited to join: "The more, the merrier." Competition will be provided on service levels, prices and provisioning times. "And on the development of new value-added facilities," BT added.

Initially, circuits will be available in multiples of 64 Kbit/s up to, and beyond if required, 16 Mbit/s. Service provisions over the GEN will be transparent to the customer, BT insisted, and business will be won, not by offering capacity on the GEN per se, but by being able to offer all-digital facilities to the five member countries much more quickly and efficiently than before.

UK: Universities Establish High-Speed Network Link

92WS0706I Chichester INTERNATIONAL TELECOMMUNICATIONS INTELLIGENCE in English 13 Jul 92 p 9

[Article: "BT Announces Start of High-Speed Network Service Trial"]

[Text] A pilot Switched High-Speed Data Service (SHDS), linking seven University sites around central London, went 'live' on June 30. The network is part of a trial being conducted by BT and the Bloomsbury Computing Consortium (BCC).

The BT service is to be based on Metropolitan Area Network (MAN) equipment supplied by Alcatel and will provide high-speed networking across London to support the interlinking of the University's own Local Area Networks (LANs). According to BT, this is the first time in the UK that a vendor has provided a network service to allow full LAN interconnection at true LAN-like speeds.

The Ethernet LANs installed on the University sites operate at speeds of 10 Mbit/s and BT's trial service will provide full interconnection between them. Until now the bandwidth of links between LANs has been limited to 2 Mbit/s with restriction on the applications undertaken.

This development is viewed by BT as the stepping stone to ATM technology which will ultimately allow full applications integration, combining voice, data and video on the same network. Until ATM is proven and reliable, BT's SHDS service is positioned to complement its frame relay service by providing networking at speeds greater than 2 Mbit/s. Both services will focus on data applications and the linking of medium and high-speed LANs.

Spain: High-Speed, High-Volume SDH Fiber-Optic Network Inaugurated

92WS0710C Paris INDUSTRIES ET TECHNIQUES in French 19 Jun 92 p 42

[Article by Laurence Girard: "Spain Inaugurates 'High Speed Train' Telecoms"; first paragraph INDUSTRIES ET TECHNIQUES introduction]

[Text]

Spain's Fiber Optic Network Makes It a Pioneer in Europe

Spain's telephone network invites the kind of comments—deficient, antiquated, trying—that the Iberian highway system did in the sixties. The national carrier Telefonica is anxious to shake off this image, which has stuck to it like glue. It has therefore decided to establish a lead, abruptly leaving behind all of its European counterparts. Telefonica is the first carrier to usher in the era of very-high-speed optical communication links, with a brand new technology dubbed Synchronous Digital Hierarchy (SDH). What is more, it has not installed SDH in a prototype system, but in a life-size network that forms a triangle between Seville, Madrid, and Barcelona. To get some idea of how ambitious this is, you need to know that international deployment of SDH is not expected before 1995.

Naturally, the Universal Exposition and the summer Olympic Games served as catalysts for the project. Telefonica was savvy enough to profit from the two events. Three companies—AT&T, Alcatel, and Philips—competed with each other after the bid invitation was issued. In the end, Philips won the contract, by digging deep into its own pockets. The Dutch company was a partner in the Barcelona Olympic Games, and shrank at nothing that could help it add that first, prestigious SDH-network reference to its calling card. So Philips built the entire infrastructure for only $10 million—a gift.

Although a high-speed linkup between Seville and Madrid seems a bit outsized, it is well suited to the Madrid-Barcelona axis, which accounts for 70 percent of Spanish telephone traffic. Each SDH linkup is actually a fiber optic highway that can transmit digital information at the rate of 2.5 Gbits/second. A mere 16 television channels, or 30,000 telephone calls, can be sent simultaneously.

The SDH standard is recognized worldwide and is derived from the American Sonet standard. It can adapt to three different transmission speeds: 155 Mbits/s, 622 Mbits/s, and 2.5 Gbits/s. The three speeds amount to designing a coherent, national network for information transport with the equivalent of freeways, national highways, and departmental roads. The SDH standard will be disseminated gradually between now and the end of the decade.

German Firm Plans Digital Fiber Optic Network

92WS0715B Frankfurt/Main FRANKFURTER ALLGEMEINE in German 14 Jul 92 p T1

[Article by Boris Schmidt: "Diamond Is to Replace Copper Coaxial Cable"]

[Text] Almost all forms of communication over short or long distances are now transmitted not in analog form but digitally. This applies to television as well. Although the question of the technical standard has not yet been clarified, systems such as PAL-Plus, D2-MAC or HDTV are the subject of lively and controversial discussion. There is no question, however, that the future television technology will be digital: The superiority not only in transmission capability is simply too great. But digitization only makes sense if it is seamless and includes all areas of distribution in communication. Consequently, the Federal German Post Office's broadband network for broadcasting programs will step by step have to be replaced by fiber optics, because the optical transmission of signals is significantly better suited for digitization.

As was now generally recognized at a gathering of technical journalists, in 20 years there will be nothing but fiberglass cables. Already work is under way today on fiberglass systems which are based on digital technology and which will later replace copper cable. Thus, the ANT company in Backnang has already invested more than 10 million German marks [DM] in its Diamond project. It is linked to the Opal pilot projects, which, although they use fiber optics, still operate in analog form. Diamond—the name is not an acronym: it symbolizes the value and importance of this technology—is derived from the way reception is taking place at this time. The basic idea of ANT's system proposal is an analog-digital conversion of the entire 450-Megaherz band and reconversion in the reception facility. In so doing—simply put—the programs are to be combined in groups; during reconversion, an analog program band is created, which, using a group converter, needs only to be placed at the desired spot on the 450-Megahertz band and can thus be directly fed to the antenna port of the end equipment.

At this time up to 64 programs can be transmitted. Television signals with a bandwidth of 7 to 14 MHz (PAL, Secam, NTSC, D2-MAC, HD-MAC), all of which are digital television programs and, of course, all radio programs, can be processed in this way. The standard international rate of 2,488.32 megabits per second was chosen for the transmission system. In order to be able to transmit 64 channels, the quadrupled rate of 9,953.28 megabits per second must be used. In order to enlarge the number of channels, however, it is also possible to use a multiphase system or one with two transmission wavelengths. ANT regards the major advantage of its concept as the compatibility of Diamond with the existing broadband network. The company anticipates that greater application of the key digital components will result in the necessary price drop, which will support a gradual introduction of digital-optical technology all

the way to the subscriber. Initially, however, optical distribution systems can only be employed where it is possible to hook up many subscribers. Otherwise the system is not profitable.

It has been proven with an eight-channel prototype that Diamond really works. The system is now being developed for serial production and will be used for the first time in 1994. Whether Diamond will really be a big success also depends on the extent to which the recipients make themselves independent of the distribution networks—no matter which one—with their own satellite antennas. But even that is not too much of a concern for ANT, for ultimately Diamond can also be used in the external broadcast area and television signals can be transmitted with Diamond coding from the program source to the subscriber. There is no longer any question that fiber optics are coming; in 1993 alone Telekom will establish local fiber optic networks for 200,000 subscribers. In each of the following years 500,000 connections are planned.

In the more distant future, optical transmission will no longer be limited to the earth. There are plans to allow satellites to communicate with one another in this manner. The principle of so-called optical free-space transmission was recognized 25 years ago in the United States and proven in the first experiments. In Europe work on space optics has been under way since the mid-1970s. In a research program by the European Space Agency (ESA), such a transmission is to be realized for the first time in 1995. Communication from satellite to satellite is possible, with a capacity of 50 megabits per second. The maximum range between the two artificial celestial bodies can be up to 45,000 kilometers. Technicians and scientists will have to make extraordinary efforts: Under extreme conditions one must, so to speak, hit a window in Munich with a light beam from Helgoland. Dreams of the future? Probably far less than the Romantis project presented last year. With it, the expanses of the former Soviet Union are to be linked by telephone via satellite. Of course, what is missing is the minor matter of $2-4 billion.